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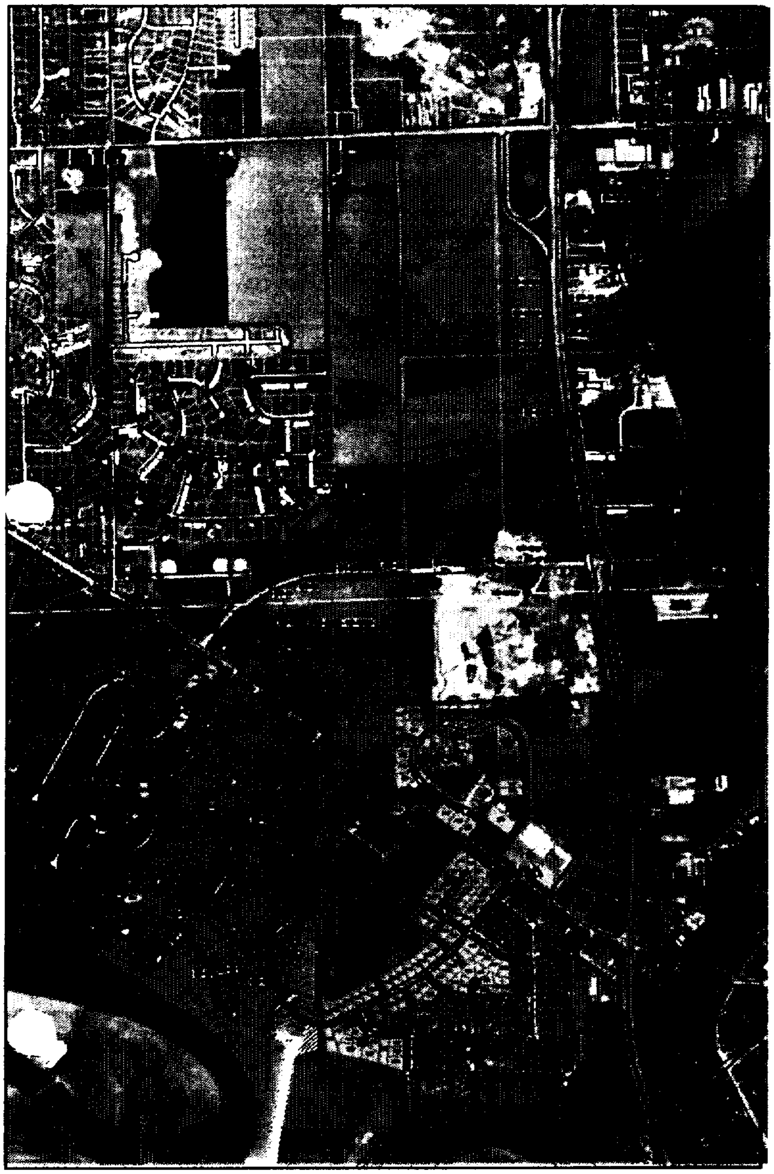
Rev. 07/10/02

Feasibility Study Report

Evergreen Manor Site
Roscoe, Illinois



July 2003

Prepared for

U.S. Environmental Protection Agency
Region V
77 West Jackson Boulevard
Chicago, Illinois 60604

Prepared by

Weston Solutions, Inc.
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Vernon Hills, IL 60061-1450

Revision 2: 21 July 2003
Revision 1: 07 July 2003
Revision 0: 17 May 2002

This document was prepared in accordance with U.S. EPA Contract No. 68-W7-0026, WESTON Region V Response Action Contract (RAC) and contains confidential business information.

Document Control No. RFW 139-2A-ANPK

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21 July 2003

Ms. Karen Cibulskis (SR-6J)
Remedial Project Manager
U.S. Environmental Protection Agency
77 West Jackson Boulevard
Chicago, Illinois 60604

U.S. EPA Contract No.: 68-W7-0026
Work Assignment No.: 139-RICO-05MZ
Document Control No.: RFW139-2A-ANPK

Subject: Feasibility Study (Revision 2) for the Evergreen Manor Site
Roscoe, Illinois

Dear Ms. Cibulskis:

Weston Solutions, Inc. (WESTON®) is pleased to submit for your review three copes of the Feasibility Study (Revision 2) for the Evergreen Manor Site, Roscoe, Illinois.

Should you have any questions or require additional information, please feel free to contact me.

Very truly yours,

WESTON SOLUTIONS, INC.

Deepak L. Bhojwani
Site Manager

DB:ld

Enclosure

FEASIBILITY STUDY REPORT
EVERGREEN MANOR SITE
ROSCOE, ILLINOIS

REVISION 2

21 JULY 2003

Prepared for
U.S. Environmental Protection Agency
77 West Jackson Boulevard
Chicago, Illinois 60604

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Document Control No. RFW139-2A-ANPK

FEASIBILITY STUDY REPORT
EVERGREEN MANOR SITE
ROSCOE, ILLINOIS

REVISION 2

U.S. EPA CONTRACT NO. 68-W7-0026
Work Assignment No. 139-RICO-05MZ
Document Control No. RFW139-2A-ANPK

Prepared and Reviewed By: Yoshie Hagiwara Date: 7/21/03
Yoshie Hagiwara
Associate Geoscientist

Reviewed By: Bhojwani Date: 7/21/03
Deepak Bhojwani
Site Manager

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SECTION 1

INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

This Feasibility Study (FS) Report for the Evergreen Manor Site (hereafter referred to as the, "Evergreen Manor Site" or "the site"), located in Roscoe, Illinois, was prepared by Weston Solutions, Inc. (WESTON®), for the United States Environmental Protection Agency (U.S. EPA) under the Region V Response Action Contract (RAC).

The purpose of this report is to develop and evaluate remedial action alternatives to address contamination in the shallow aquifer (up to approximately 100 feet [ft] below ground surface [bgs]) underlying the Evergreen Manor Site. In general, this document is based upon the findings of the Groundwater Data Evaluation Report (GDER), Revision 1 (WESTON, 2003) which presented and evaluated all groundwater, sediment, and surface water chemical data collected from 1990 to 2002 and the Air Sampling Report, Revision 3 (WESTON, 2003) which presented and evaluated ambient air, soil gas, and indoor air results of the 2002 Air Investigation. Specifically, the alternatives developed and presented in this document are based on the findings of the 2000 Remedial Investigation (RI) Report, Revision 1 (WESTON, 2001), the results of groundwater field investigation activities conducted in April 2002, and the results of the Air Sampling Report, Revision 3 (WESTON, 2003).

This FS Report, prepared in accordance with the U.S. EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (U.S. EPA, 1988), focuses on remedial alternatives that address the human health and ecological risks presented by shallow groundwater at the Evergreen Manor Site. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300), states a preference for developing two types of alternatives:

- Alternatives that contain treatment to reduce the toxicity, mobility, and volume of contaminants as a principal element; and

- Alternatives that protect human health and the environment primarily by preventing or controlling exposure to hazardous substances.

This FS includes both types of alternatives.

1.1.1 Feasibility Study Process

As stated earlier, this FS Report was prepared in accordance with the U.S. EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (U.S. EPA, 1988). This U.S. EPA guidance document provides an approach to identify and analyze remedial alternatives. Remedies can involve: (1) natural attenuation; (2) destruction of contaminants or a reduction in their volume, toxicity, or mobility; and (3) reduction of exposure pathways. The "No Action" alternative is required by the Comprehensive Environmental Response and Liability Act (CERCLA) to be carried forward to the detailed analysis phase in order to provide a baseline comparison with the other alternatives. The No Action alternative or an alternative consisting of only institutional controls may be selected if the remedy is protective of human health and the environment.

The FS process consists of the following steps:

- Development of Remedial Action Objectives (RAOs) that specify the contaminants of concern, exposure pathways, and remediation goals that permit a range of alternatives to be developed. RAOs are developed on the basis of chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs);

- Development of general response actions that define containment, treatment, removal (collection), disposal, or other actions that may be implemented singly or in combination to satisfy the RAOs;

- Identify the volumes or areas of contamination that do not meet RAOs and to which the general response actions apply;
- Identify and screen remedial technologies for each general response action to eliminate technologies that are not effective based on site and waste characteristics or that cannot be technically or cost-effectively implemented;
- Identify and screen specific process options within each remedial technology such that the most appropriate process option(s) may be identified; and
- Assemble the retained process options into alternatives, screen the alternatives, and evaluate retained alternatives.

1.1.2 Report Organization

This report is organized in accordance with U.S. EPA guidance (U.S. EPA, 1988). The remainder of this section provides background information for the Evergreen Manor Site and a summary of RI activities conducted to date. Section 2, Identification and Screening of Technologies, describes the process used to develop RAOs, presents general response actions, and identifies and screens potential remedial technologies and process options. Section 3, Development of Alternatives, combines retained technologies identified in Section 2 into remedial alternatives that address RAOs for the site. Section 4, Analysis of Alternatives, presents a detailed analysis of each remedial alternative based on NCP criteria (U.S. EPA, 1988) and compares the alternatives to each other, and Section 5 presents the various references used in preparing this document.

1.2 SITE DESCRIPTION

The Evergreen Manor Site is located approximately 1.5 miles northwest of Roscoe, Winnebago County, Illinois. The site includes four residential subdivisions (Hononegah Heights, Tresemer, Olde Farm, and Evergreen Manor) and has been defined by the extent of groundwater contamination in the shallow aquifer. The location of the site is shown in Figure 1-1. A site layout map, which depicts the locations of the residential subdivisions, area businesses and industries, and other pertinent site features, is provided as Figure 1-2. The site extends over Sections 16, 20, 21, 29, and 32 in Township 46 North, Range 2 East, and is found on the South Beloit, Illinois/Wisconsin Quadrangle. The coordinates of the site are latitude 42^{o} 26' 32.0", longitude 89^{o} 01' 36.0".

The residential subdivisions were farmland prior to development. The Hononegah Heights subdivision was developed between 1940 and 1964; the Tresemer subdivision was developed between 1972 and 1974; the Olde Farm subdivision was developed between 1976 and 1979; and the Evergreen Manor subdivision was developed between 1986 and 1988. With the exception of the Evergreen Manor subdivision, most of the development occurred before 1980 (IEPA, 1992).

The subdivisions are bounded to the south by the Rock River and to the west by the Hononegah Forest preserve. East of the subdivisions are agricultural fields and the Hononegah Country Estates subdivision. North of the subdivisions is a 1-mile tract of agricultural land, with a smaller residential area and various industries east of the agricultural land, east of Route 251.

Roscoe Rock and Sand, Inc., a gravel pit and concrete mixing facility, is located approximately 0.5 miles northeast of the subdivisions. Roscoe Rock and Sand, Inc. purchased the former Kelley Sand and Gravel property, and is located on the north and south sides of McCurry Road, west of Route 251.

The industrial park, located north of Rockton Road, and east of Route 251, contains the following businesses: Inlander-Steindler Paper Company, Regal-Beloit Corporation, McGuire Brothers Auto Body and Sand Blasting, Makerite Manufacturing Company, Midwest-Precision Grinding, Rockford Steam Boiler Works, Oscar's Auto and Battery Clinic, Dayles Welding, Armour Specialty, Inc. (industrial painting), RD Systems, Electro Cam Corporation, Area Elevator, DGM, Preston 151 (trucking firm), and Indicon Midwest (IEPA, 1992).

The industries located on the south side of Rockton Road, east of Illinois Route 251 include Ecolab and Taylor Design, Inc. Further south along and east of Illinois Route 251 are five other facilities: State Line Foundries, Waste Management Transfer Station , Kenny's Cars, Trucks and Equipment, Stateline Printing Company, and Stateline Storage. Warner Brake and Clutch is located south of McCurry Road on the east side of Route 251 (IEPA, 1992).

1.3 ENVIRONMENTAL SETTING

1.3.1 Demography and Land Use

The Evergreen Manor site in Roscoe Township, Winnebago County, Illinois includes four residential subdivisions. The site consists of an area of VOC-contaminated groundwater and has been defined by the maximum extent of these detections. The location of the historical and existing groundwater monitoring points, site boundaries, and surrounding physical features is provided in Figure 1-2.

According to the 2000 U.S. Census, the town of Roscoe is in Census Tract 003902, Block Group 2, and has a total population of 6,244, 3% of whom are minorities. Based on the estimated extent of the VOC contamination plume, the Evergreen Manor site has the potential for affecting 243 homes and an estimated population of 700 persons (IDPH, 1999).

Land use in and around the site is residential, agricultural, commercial and industrial. The land from Hononegah Road to the Rock River is residential. Directly north of Hononegah Road is commercial property with various stores in a strip mall. Between the strip mall and Rockton Road, on the west side of Illinois Route 251, most of the land is agricultural and is actively used during the growing season. This area also includes an area of heavy industrial land use: a sand and gravel quarry and cement mixing facility. To the east of Illinois Route 251, from Hononegah Road to Rockton Road, land use is mixed between commercial, light industrial and residential. This area includes the Ecolab facility, the Waste Management Transfer Station, Kenny's Cars, Trucks, and Equipment, as well as other companies. In the northeast quadrant of Illinois Route 251 and Rockton Road most of the land is light industrial and is occupied by an industrial park.

1.3.2 Climate

Winnebago County has a continental climate typical of northern Illinois. This area has hot summers and cold winters, with July being the hottest month and January being the coldest. The average temperature in winter is 23°F and in summer is 71°F. The lowest recorded temperature was -22 °F recorded on 21 January, 1970. The highest recorded temperature was 103 °F recorded on 27 July, 1955. Annual precipitation averages 38 inches and annual snowfall averages 33 inches. Sixty-six percent of the rainfall occurs between the months of April through September.

1.3.3 Ecology

The site is located in the Central Lowland geomorphic province, in the eastern broadleaf forest province of the Hot Continental Division in the Humid Temperate Domain (USDA Forest Service, Ecological Subregions of the United States, http://www.fs.fed.us/land/pubs/ecoregions).

The Rock River receives drainage from three major streams - the Pecatonica River, the Kishwaukee River, and the Green River. It is 163 miles long in Illinois, and drains 2,272,000 acres in Illinois. Of the total river miles in this basin, 69 stream miles have "good" overall resource quality and 97.9 miles have "fair" quality. The Rock River enters the Mississippi River at Rock Island (IDNR, http://dnr.state.il.us/lands/education/valerie/end/page6.htm). Dry Creek, a tributary of the Rock River and an intermittent stream, enters the river northwest of the Tresemer Subdivision. West of Dry Creek, the river is classified by the NWI as a riverine wetland and east of the creek, the river is classified as a lacustrine system. Forested wetlands border both the river and the creek west of the site and the river south of the site. There are small areas of emergent wetlands within the Evergreen Manor subdivision.

The U.S. Fish and Wildlife Service (USFWS) was contacted to obtain information on threatened and endangered species within the Evergreen Manor project area. Species that may be present in the area include the endangered Indiana bat (*Myotis sodalis*), the threatened prairie bush clover (*Lespedeza leptostachya*), the threatened bald eagle (*Haliaeetus leucocephalus*).

1.3.4 Regional Topography

The topography in Winnebago County has been created in large part by features developed during the advance and retreat of glaciers. This includes till plains that contain kames, drumlins, and eskers (USDA-NRCS, 1980). The Evergreen Manor site is located on a broad, flat terrace, which gently slopes toward the Rock River. Locally, relief is no greater than about 75 feet from the highest area near Rockton Road and IL Route 251 (approximately 770 to 775 feet above mean sea level [amsl]), down to the Rock River elevation of approximately 700 feet amsl.

1.3.5 Regional Geology

The geology in the vicinity of the Evergreen Manor site has been most heavily influenced by fluvial and glacial processes. The preglacial Rock River incised a deep bedrock valley that was subsequently buried during glaciation. As the glacier retreated, vast deposits of sand and gravel with lesser amounts of silt and clay were deposited in the river valley. The Evergreen Manor site is located in the preglacial Rock River buried valley.

Surficial Geology

The surficial geology in the vicinity of the Evergreen Manor site consists of windblown sand and silt, lacustrine sand, silts and clays, and sand and gravel outwash deposited within the preglacial Rock River valley. Till deposits are found primarily along the valley margins. The valley was primarily filled with deposits from the Quaternary Period, during the Illinoian and Wisconsinan glacial events.

The sand and gravel outwash deposits are the most abundant and most extensive deposits in the buried valley, and can reach a thickness of up to 300 ft. in the vicinity of the Evergreen Manor site (IDENR, 1960).

Bedrock Geology

The bedrock geology in the vicinity of the Evergreen Manor site is characterized by the Ordovician and Cambrian clastic and carbonate rocks. Both the Galena and Platteville dolomite, and the underlying Ancell Groups represent the Ordovician Period in this area. The Ancell Group consists of the Glenwood formation, a sandy shale, and the underlying St. Peter sandstone, a well-sorted sandstone up to 400 ft thick. The ancient Rock River eroded the Galena and Platteville dolomite, and the Glenwood, and carved its valley into the St. Peter sandstone (Colten and Breen, 1986).

The Cambrian rocks are dominated by sandstones with lesser thicknesses of shale and dolomite. The Potosi (dolomite) and Franconia (sandy shale) formations lie on top of the Ironton-Galesville sandstone and separate it from the Ordovician rocks. The Ironton-Galesville sandstone has a thickness of up to 170 ft. The thickness of underlying Eau Claire Formation may reach up to 450 ft, and the Mt. Simon sandstone below can reach up to 1600 ft in thickness.

The sedimentary bedrock units in the vicinity of the Evergreen Manor site were deposited on an irregular surface of metamorphic and igneous Precambrian rocks. Beneath the site, the Precambrian consists of a granite (Colten and Breen, 1986).

1.3.6 Surficial Soil

The predominant surficial soil type mapped for the site and surrounding area is the Warsaw loam (USDA-NRCS, 1980). The Warsaw loam is a nearly level to gently sloping soil found on terraces, convex ridges, outwash plains, gravelly kames and stream terraces. Depending on the slope, the surface layer is about 10 to 12 inches thick and consists of a very dark gray to a very dark brown loam. The subsoil is from about 24 to 41 inches thick and consists of loam to gravelly loam and varies in color from dark grayish brown to brown to dark reddish brown. The substratum, to a depth of about 60 inches, consists of yellowish brown, calcareous sand and gravel. The permeability of the Warsaw loam is moderate to rapid, with moderate water capacity, and moderate organic matter content (USDA-NRCS, 1980).

Other soil types exist within the site area. Soil types located near the Rock River and Dry Creek are characterized by higher clay contents and moderate permeabilities. Other soil types, further from the water ways, are characterized by higher sand or sand and gravel contents and rapid permeability (USDA-NRCS, 1980).

1.3.7 Regional Hydrogeology

The unconsolidated sand and gravel outwash deposits, the St. Peter, Ironton-Galesville, and Mt. Simon sandstones are the aquifers underlying the site. The sand and gravel outwash deposits have significant permeability and transmissivity and are the predominant local water source for private residences in the vicinity of the preglacial Rock River Valley. The typical lithology encountered during the field activities completed between 2000 and 2002 is depicted on Figure 1-3. This figure represents a cross-section adapted from the 2000 RI Report. Larger wells owned or used by municipalities or developments draw groundwater from both the bedrock aquifers and the shallower glacial drift formations.

The sand and gravel outwash is an unconfined aquifer with more uniform (i.e. better sorted) deposits at depth. Hydraulic conductivity test results were conducted within the shallow sand and gravel outwash aquifer in the 1980's by the Illinois Department of Energy and Natural Resources (IDENR). Pressure tests were conducted at four well clusters, at depths between 40 and 80 feet bgs, and an average hydraulic conductivity was found to be 3.8×10^{-2} cm/sec (Wehrmann, 1984).

According to the IEPA's Hazard Raking System Documentation Record (IEPA, 1997), the Galena and Platteville dolomite is a regional aquitard with an estimated hydraulic conductivity of $1x10^{-8}$ to $1x10^{-11}$ cm/sec (IEPA, 1997). However, Colten and Breen (1986) recognize the Galena-Platteville as a regional aquifer of importance for small-demand, rural domestic and livestock water supply. In addition, the U.S. EPA site geologist has noted that based on experience, in north-central Illinois, it is more appropriate to consider the Galena-Platteville dolomite a residential water-supply aquifer rather than an aquitard, and that the hydraulic conductivity values cited above for the Galena-Platteville are on the low side for this area. However, since most of the flow in the dolomite is through vertically oriented fracture and joint systems (Colten and Breen, 1986), the hydraulic conductivity may vary depending of the amount of fractures and the presence of joint-sets.

The Glenwood Formation, consisting of shale overlying a poorly sorted sandstone, has an estimated hydraulic conductivity of $1x10^{-4}$ to $1x10^{-7}$ cm/sec (IEPA, 1997).

The St. Peter sandstone aquifer underlies the Galena-Platteville aquifer/aquitard and Glenwood semi-confining unit, except along the axis of the Rock River buried valley, where the overlying bedrock has been removed by erosion. The St. Peter sandstone has an estimated hydraulic conductivity of $1x10^{-4}$ cm/sec and is widely used as a water source in Winnebago County (IEPA, 1997).

The Ironton-Galesville sandstone is a regionally confined unit and a very productive aquifer. However, due to its depth, few wells are finished in the Ironton-Galesville sandstone (Colten and Breen, 1986). The same holds true for the Mt. Simon sandstone, which can reach a thickness of 1,600 feet, and overlies the Precambrian granite.

1.3.8 Site Hydrogeology

The shallow hydrogeology in the vicinity of the Evergreen Manor site is that of an extensive unconfined sand and gravel outwash aquifer (mostly Henry and Glasford formations). Groundwater elevations were found to be consistently the same in shallow and deep cluster wells, and varied in elevation between 710 and 731 feet above mean sea level (MSL) during the April 2002 Investigation. Groundwater flow at the site is from the northeast to the southwest toward the Rock River as shown on Figure 1-4. The Rock River is presumed to be the groundwater discharge location for the shallow sand and gravel outwash aquifer. The gradient across the site is fairly uniform and based on the contours shown on Figure 1-4 is approximately 0.0015 ft/ft.

The Galena and Platteville dolomite and the Glenwood formations are not present beneath the Evergreen Manor site due to the ancient Rock River carving its valley into the St. Peter Sandstone. From NPPWD well logs, it is inferred that in the vicinity of the Evergreen Manor site, the glacial outwash aquifer lies directly on top of the St. Peter Sandstone, which is underlain by the Potosi (or Trepealeau) formation.

1.3.9 Regional Surface Water Hydrology

The Evergreen Manor site lies in the Lower Rock River drainage basin. The Rock River originates in Wisconsin and enters Illinois south of Beloit. In Illinois, the Rock River flows in a southwesterly direction to its confluence with the Mississippi at Rock Island. In the vicinity of the site, the Rock River flows generally in a north to south direction. Two lakes, Pearl Lake and Victoria Lake, are located north of the site, west of Illinois Route 251. These lakes are former sand and gravel pits.

Dry Creek, a tributary of the Rock River, enters the river northwest of the Tressemer Subdivision and is the only drainage-way that traverses a portion of the site and ultimately flows into the Rock River in the Hononegah Forest Preserve. In Rockton, the mean daily discharge of the Rock River ranges from 2839 cubic feet per second (cfs) in September to 7375 cfs in April, with an annual mean of 4178 cfs (USGS, CD-ROM, Current Year Discharge, http://www.il.water.usgs.gov/cd04-99/dis_tbl/05437500.htm). The Rock River is the southern boundary of the site. Because of the permeable nature of the sand and gravel outwash deposits underlying the site, most of the precipitation is expected to infiltrate into the subsurface and percolate to the groundwater table. However, Dry Creek will also receive surface runoff during wet periods, when rainwater ponds, or during heavy rainfall. The staff gauge reading from the 6 June 2000 RI field investigation indicated that the water level in Dry Creek was approximately 11 feet higher than the water table elevation in the closest wells (MW-110S and D). Based on these readings, Dry Creek is not expected to be in direct hydraulic connection with the groundwater table at that location. Dry Creek was classified as a losing stream at the time of the 2000 RI, indicating that it would contribute water to the subsurface. The amount of water that is lost from Dry Creek to the subsurface is expected to be minimal, since the channel bottom sediments are clay and silt rich.

In the residential areas, primarily south of Hononegah Road, the surface drainage pattern has been somewhat altered by construction of roadways, driveways, and buildings. Although precipitation will percolate through the lawns in the residential area, a portion will be carried by the ditch system to the Rock River.

1.3.10 Evergreen Manor Site Plume & Groundwater Use

The Hononegah Heights, Evergreen Manor, Tressemer and Old Farm subdivisions are part of Roscoe Township. Roscoe Township is located within the North Park Public Water District (NPPWD), however, not all residences within these subdivisions receive their water from the NPPWD. Prior to 1999, the residences within the subdivisions obtained their water from private residential wells. Based on limited well construction data available for review, these residential wells were completed within the shallow sand and gravel outwash deposits at average depths of 55 to 65 feet bgs, with depths ranging from 43 feet to 105 feet bgs. Due to the VOC-affected groundwater in the shallow aquifer related to the Evergreen Manor site and the Warner Electric RCRA site, many of the residences in the area are connected to the NPPWD water supply system, and private wells associated with these homes have been abandoned.

The boundaries of the Evergreen Manor site have been established using the groundwater data collected 1990 through 2002. The site boundary as interpreted based on the maximum extent of VOCs detected from 1990 through 2002 is depicted in Figure 1-2. Figure 1-2 also shows a smaller plume which is representative of current VOC contamination extent observed during the 2000 RI and the 2002 Investigation. The groundwater components of the remedial alternatives, discussed and presented in this report, are based on results of the 2000 RI and the 2002 Investigation.

Between 1999 and 2000, the U.S. EPA connected a total of 262 residences located within the Evergreen Manor site to the NPPWD water supply. In addition, 19 of 21 homes included in a "buffer zone" were connected to the NPPWD water supply as a precaution. These residences are depicted on Figure 1-5. It should be noted, however, that due to the uncertainties associated with the exact addresses not all residences connected to the NPPWD are shown. At the request of the current landowners, two homes located within the southern perimeter of the "buffer zone" were not connected to the NPPWD water supply. As shown in Figure 1-5, these two residences are located outside of the eastern boundary of the contamination plume. In May 2001, five residences located adjacent to the contamination plume, including one which had previously declined to be connected to the NPPWD water supply, were sampled by the IDPH. The results of this sampling indicated that the groundwater in the vicinity of these residences has remained unaffected by the site contamination. Upon review of the NPPWD service records, it is apparent that additional residences and/or commercial properties within the vicinity of the Evergreen Manor Site may be using private wells for potable water. These locations are depicted on Figure 1-6.

To reduce the likelihood of exposure to the contaminated groundwater beneath the Evergreen Manor site, Winnebago County has implemented an ordinance that requires all residences to be connected to a public water supply system if they are within 200-feet of a system. In addition, the county requires property owners to obtain well permits for new or existing well repairs. This permit provides the county the opportunity to notify the applicant about the location of a contamination plume and provide recommendations for additional water treatment, as well as require new wells to be drilled to depths believed to be beneath a contamination plume.

Two municipal wells (#6 and #6A) that provide a portion of the water to the NPPWD are located at the corner of Hononegah Road and Cedarbrook Road. These wells are installed to a depth of 780 feet bgs. These wells are currently on "standby" status and are only used during periods of peak demand (e.g., summertime or drought conditions). Although well construction details indicate these wells were cased to a depth of 550 feet bgs, recent downhole logging efforts conducted in November 2002 on Well #6 by U.S. EPA show that this well is only cased to 450 feet bgs. Therefore, groundwater is withdrawn from a depth of approximately 450 feet to 780 feet bgs primarily from the Ironton-Galesville Sandstone. Well construction details indicate these wells are outfitted with 60-hp Byron-Jackson submersible pumping equipment rated at 470 gallons per minute (gpm). Pump tests conducted on Well #6A in November 2002 by U.S. EPA and the USGS indicate the average pumping rates for this well were between 380 and 410 gpm.

PCE has been intermittently and inconsistently detected above the MCL of 5 μg/L in these municipal wells since 1985. U.S. EPA investigations have shown that a PCE-based coating material was apparently used on piping within this well during construction and is likely responsible for contaminant levels observed in this well.

The NPPWD owns and operates six wells within its distribution system, including Wells #6 and #6A. The remaining four wells are installed within shallow sand and gravel deposits, but are located three to six miles from the Evergreen Manor groundwater contamination site; and therefore, do not appear to be threatened by the groundwater plume.

1.4 PREVIOUS INVESTIGATIONS

1.4.1 Site Discovery and Initial Characterization (1990 to 1991)

The Evergreen Manor site was first identified in November 1990 when a local lending institution required a homeowner within the Evergreen Manor subdivision to sample and analyze the drinking water from its on-site water well. Results of the analysis indicated the presence of elevated concentrations of VOCs. Additional sampling was conducted by the IDPH in the area and identified VOCs in excess of regulatory criteria for drinking water (i.e., MCLs) for several VOC constituents in one or more wells. Based on these results, the IDPH concluded that groundwater underlying at least 130 residences in the Hononegah, Olde Farm, Evergreen Manor, and possibly the Tresemer subdivisions could be contaminated with VOCs (IEPA, 1992). On 3 August 1991, the Evergreen Manor site was added to the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS).

1.4.2 CERCLA Screening Site Inspection (1992)

A Site Screening Inspection (SSI) was performed at the Evergreen Manor site in June and August 1992 to gather information for potential Hazard Ranking by the IEPA (IEPA, 1992). As part of the SSI, a total of 39 soil gas samples and four groundwater samples were collected and analyzed for 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), and 1,1-Dichloroethene (1,1-DCE).

Soil gas samples collected along McCurry Road, east of IL Route 251, and along the frontage road east of IL Route 251 indicated the presence of 1,1,1-TCA, TCE, and 1,1-DCE. The compounds were not detected in soil gas samples collected from the north side of the Ecolab facility, and along the north side of Rockton Road (IEPA, 1992).

The results of the groundwater analyses did not indicate the presence of VOCs in the samples collected from the north side of the Ecolab facility, or along the frontage road. Three VOCs were detected in a well north of the Waste Management facility (IEPA, 1992).

The SSI Report assigned a high priority to the Evergreen Manor site based on the results of the SSI and the groundwater samples collected from residential wells by IDPH between 1990 and December 1991.

1.4.3 CERCLA Expanded Site Inspection (1993)

An Expanded Site Inspection (ESI) was conducted by the IEPA in November 1993 (IEPA, 1994). During the ESI, a total of 49 groundwater samples were collected from 45 residences in three subdivisions (including Hononegah Heights, Olde Farm, and Evergreen Manor), four of which were duplicate samples. The groundwater samples were analyzed for VOCs (IEPA, 1994).

Results of the ESI indicated that in all but one of the samples, and excluding two background samples, at least one VOC was detected. 1,1,1-TCA and TCE were detected at concentrations of less than 10 micrograms per liter (μg/L) to 37 and 40 μg/L, respectively. Of the 45 wells sampled, 36 wells had 1,1,1-TCA concentrations significantly above background, and 40 wells had TCE concentrations significantly above background. All TCE detections were at concentrations greater than the MCL (5 μg/L) (IEPA, 1994).

1.4.4 Other IEPA and IDPH Investigations

A number of other investigations, outside of the scope of the PA, SSI, and ESI, were conducted at the Evergreen Manor site. Results of these investigations are included in an *ACTION MEMORANDUM* (U.S. EPA, 1999) and are summarized below:

- Between December 1990 and March 1994, IEPA and IDPH sampled 267 drinking water wells, mostly in the four subdivisions which define the Evergreen Manor site. These wells included wells that were sampled as part of the SSI and the ESI. VOCs were detected in 203 wells. VOCs in 108 wells exceeded their respective MCLs.

- Between December 1993 and February 1995, IEPA installed and sampled 24 monitoring wells. Sample results from March 1994 indicated that TCE and PCE exceeded their respective MCLs (5 µg/L) in two out of 20 wells. Sample results from February 1995 indicated that groundwater collected from three out of 24 wells exceeded the MCLs for TCE, and four exceeded the MCL for PCE.

- Sample results from 12 wells sampled by U.S. EPA on 22 May 1998 indicated that groundwater from six of the wells exceeded the MCL for TCE, and groundwater from three of the wells exceeded the MCL for PCE.

1.4.5 Hazard Ranking System (HRS) Documentation Record (May 1997)

Based on the information and data gathered during the PA, the SSI, the ESI, and other sampling conducted by IEPA and/or IDPH, a HRS score was prepared (IEPA, 1997). The Evergreen Manor Ground Water Contamination Plume, ILD 984836734, received a score of 100 points for the groundwater pathway. The air, soil, and surface water pathways were not evaluated. The final HRS site score was 50 points. The HRS document included the information on three likely sources of the groundwater contamination at the Evergreen Manor site. These potential sources included the waste disposal areas that were located on the properties of Regal-Beloit, AAA Disposal (property now owned by Waste Management), and Ecolab near Route 251 and Rockton Road. From the HRS package and other IEPA documents, the likely sources of the groundwater contamination at the Evergreen Manor site are identified as follows:

- A landfill at former AAA Disposal System that was covered with soil and granted closure by IEPA in 1977. In 1990, 1,380 cubic yards of material was also excavated from this property and removed by the current property owner, Waste Management. Soil samples collected from the site contained low levels of TCE (13 µg/kg), 1,1-DCA (8 µg/kg), cis-1,2-DCE (15 µg/kg) and PCE (6.8 µg/kg), and higher levels of benzene (1,000 μg/kg), toluene (940 μg/kg) and xylene (7,300 μg/kg). Samples Waste Management collected from the nearby Schewbke property in 1990 also contained PCE at 40 μg/kg.

- Wastewater discharged to a septic field and 5 underground storage tanks at Regal-Beloit which were closed under RCRA in 1987. Soil samples collected from the site contained low levels of TCE (7 μg/kg) and 1,1,1-TCA (2 μg/kg).

- A wastewater lagoon at Ecolab that was removed under IEPA oversight in 1979. MW-103, installed immediately downgradient of Ecolab had the highest concentrations of PCE (40 μg/L) and 1,1,1-TCA (16 μg/L)"

1.4.6 Engineering Evaluation / Cost Analysis Report (October 1998)

An Engineering Evaluation/Cost Analysis (EE/CA) Report was prepared by the U.S. EPA with the objective of evaluating removal action objectives and removal action alternatives. Three viable alternatives were identified which would abate the threat posed by drinking the VOC contaminated groundwater encountered beneath the Evergreen Manor site. These included a point-of-entry carbon filter treatment option, a point-of-use carbon filter treatment option, and an option to connect the affected residences to a public water supply system.

1.4.7 Action Memorandum (2 March 1999)

On 2 March 1999, an Action Memorandum was issued by the U.S. EPA and served as a request for CERCLA Non-Time Critical Removal Action (NTCRA) and consistency exemption to the $2 million and 12 month statutory limit at the Evergreen Manor site. The U.S. EPA recommended the extension of the public water supply system in order to provide the affected residences within the Evergreen Manor site with safe drinking water, and abandon the existing residential wells. This decision was based on the permanence of the solution and the public response to the EE/CA during the public comment period, which opened on 10 November 1998 (U.S. EPA, 1999).

The Evergreen Manor site contamination was estimated to affect 700 people in approximately 250 residences. A preliminary risk assessment indicated that the continued usage of residential wells would pose a threat to public health and the environment. Since the concentrations of TCE and PCE exceeded the MCLs, this condition represented an imminent and substantial endangerment to local residents.

The source area was identified in the Action Memorandum as the area at the intersection of Rockton Road and Route 251.

1.4.8 Administrative Order of Consent (14 May 1999)

U.S. EPA entered into an administrative order of consent (AOC) with three PRPs concerning the Evergreen Manor Groundwater Contamination Site. The AOC required the PRPs to pay a total of $2,100,850 to partially fund the removal action to be performed by U.S. EPA. The removal action consisted of construction of a water main extension to bring potable water from the North Park Public Water District to the individual residences threatened by contaminated groundwater. The U.S. EPA provided a list of those residences deemed eligible for connection to the NPPWD water main in the *July 1999 Construction of Water Main Extension Project to Begin at the Evergreen Manor Groundwater Contamination Site* Fact Sheet. Work related to the extension of the public water supply system and hookup of the affected residences commenced in 1999, and was completed on September 29, 2000. At that time, all the private wells at the residences connected to the municipal water supply by the U.S. EPA were permanently abandoned.

1.4.9 Remedial Investigation (March 2000)

From May through June 2000, a Remedial Investigation (RI) was completed at the Evergreen Manor site (WESTON, 2001). The objectives of the RI were to gather site information in support of a Feasibility Study (FS) and to make an informal risk management decision regarding an appropriate remedy.

A total of 138 groundwater samples (including duplicates) were collected and analyzed. Groundwater samples were collected from 22 residential wells, 15 IEPA shallow and deep wells at eight locations, and 72 groundwater samples from multiple depths at 10 cone penetrometer testing (CPT) locations. In addition, fracture trace analysis was conducted.

A total of 13 VOCs were detected in samples collected from CPT, monitoring wells, and residential wells. As a result of screening against regulatory screening levels, chloroform, tetrachloroethene, and trichloroethene were considered consituents of concern (COCs). Six sediment and surface water samples (each) were collected and analyzed for VOCs. Four VOCs were detected in only one sediment sample. No VOCs were detected in the rest of the sediment samples and any of the surface water samples. No COCs were identified in sediment or surface water media after comparing against their respective evaluation criteria.

Based on the results of the groundwater analytical data and a fracture trace analysis, the RI identified the industrial area near the intersection of Rockton Road and Illinois Route 251 as the likely source area of contamination. Human and ecological risk assessment was also conducted as a result of 2000 investigation, and the results are discussed in Section 2, Identification and Screening of Technologies.

Additional RI details can be found in the Remedial Investigation Report, Revision 1 (WESTON, 2001).

1.4.10 April 2002 Field Investigation

During April 2002, an additional field investigation was completed at selected areas of the Evergreen Manor site by the U.S. EPA. As part of this investigation, four additional groundwater monitoring wells were installed, two municipal water supply wells were sampled, and sediment, surface water and groundwater samples were collected. Three newly installed wells and 12 existing wells were sampled for VOCs. The results of these sample analysis indicated that the following constituents were detected; 1,1-DCA, 1,1-DCE, cis-1,2-DCE, 1,1,1-TCA, TCE, PCE, Freon 113 and chloroform.

Two municipal wells (#6 and #6A) were also sampled and analyzed for VOCs. PCE was detected above the method detection limits in all the municipal water well samples. A total of eight investigative sediment samples and eight investigative surface water samples were collected from the Rock River. Freon 113, 2-butanone, and toluene were detected in the sediment samples. No VOCs were detected in surface water samples.

1.4.11 2002 AIR SAMPLING

A limited soil gas and indoor air quality investigation was undertaken by U.S. EPA at four locations within the residential area (WESTON, 2003). The objective of the air sampling program was to measure the concentrations of VOCs in ambient air, indoor air, and soil gas at four selected residences in different areas of the Evergreen Manor site.

Based on information collected during the air sampling program, benzene, chloroform, ethylbenzene, methylene chloride, PCE and TCE were detected above target risk-based concentrations (RBCs) in soil gas and indoor air samples. Indoor air sampling results indicated potential cancer risks for potentially site-related constituents (primarily PCE and benzene) were within the U.S. EPA's acceptable risk range. The overall potential cancer risk from all chemicals detected in the homes ranged from 1×10^{-4} to 1×10^{-5}. These risks were also within U.S. EPA's acceptable risk range. Similarly, there were no noncancer risks found from site-related chemicals. Soil gas sampling results indicated potential cancer risks for potentially site-related constituents (primarily TCE, PCE, and benzene) were within the U.S. EPA's acceptable risk range. No noncancer risks were identified from soil gas data.

Additional details regarding the air sampling investigations can be found in the Air Sampling Report, Revision 3 (WESTON, 2003).

1.5 HISTORICAL DATA EVALUATION

As mentioned previously in this section, since 1990 several groundwater investigations have been conducted at the Evergreen Manor site. A comprehensive data evaluation was conducted in an attempt to thoroughly and comprehensively evaluate all data and information collected at the site between 1990 and 2002. This resulted in identification of applicable constituents of concern and yielded an overall conceptual model of the Evergreen Manor site groundwater plume as of 2002. Details of this evaluation can be found in the GDER, Revision 1 (WESTON, 2003). Air Investigation has been conducted only once during 2002. Details of the Air Investigation results can be found in the Air Sampling Report, Revision 3 (WESTON, 2003). Relevant portions of the GDER and the Air Sampling reports are summarized in the following subsections.

1.5.1 Evaluation Criteria

During the evaluation of historical groundwater data, groundwater analytical results (monitoring well and residential well data) were compared to the following evaluation criteria:

- MCLs for drinking water established under the Safe Drinking Water Act (40 CFR 141.61 - MCLs for Organic Contaminants).
- IEPA Tier 1 Groundwater Remediation Objectives [Table E in Appendix B of Title 35, Environmental Protection, Part 742, Tiered Approach to Corrective Action Objectives (TACO)] values.
- Lowest available U.S. EPA Ecotox Thresholds.
- Most conservative Water Quality Criteria and Guidelines for the Protection of Aquatic Life (WQCAL) obtained from *the Compendium of Environmental Quality Benchmarks* published by Environment Canada.

Analytical results for sediments were compared to the following criteria:

- U. S. EPA Region IX Risk-based Criteria based on soil standards for residential properties.

- IEPA Tier I Soil Remediation Objectives based on soil standards for inhalation and ingestion exposure route for residential properties.

- Lowest available U.S. EPA Ecotox Thresholds.

- Most conservative Sediment Quality Criteria and Guidelines for the Protection of Aquatic Life (SQCAL) obtained from *the Compendium of Environmental Quality Benchmarks* published by Environment Canada..

The above criteria are shown in Table 1-1. Results of the indoor air, soil gas, and ambient air samples were compared with the most conservative risk-based concentrations (RBCs) developed from two sources–U.S. EPA Region IX PRGs for ambient air (U.S. EPA, 2002a) and U.S. EPA Vapor Intrusion Guidance (VIG) values (U.S. EPA 2002b).

1.5.2 Nature and Extent of Contamination

The GDER, Revision 1, conclusions regarding the nature and extent of contamination are as follows:

- Historically, TCE and PCE concentrations in residential wells, monitoring wells, municipal wells, and CPT sampling locations have consistently exceeded the MCL, the TACO and the WQCAL values. TCE and PCE were not detected in any sediment and surface water samples. TCE and PCE were also reported in the soil gas samples. TCE exceeded the most conservative target RBC in soil gas samples collected from the central, the west-central and the southern residential areas of the groundwater plume. PCE exceeded the most conservative target RBC in soil gas sample collected from the west-central residential area of the groundwater plume. The highest PCE and TCE concentrations of 190 $\mu g/m^3$ and 9.5 $\mu g/m^3$, respectively, were reported in a soil gas sample collected from the residence located in the central-western residential area of the groundwater plume, where, historically, PCE and TCE concentrations in the residential wells have been either non-detect or detected at concentrations below the drinking water standards. No PCE detection has ever been reported in this area of the groundwater plume. PCE and TCE were also detected in soil gas samples at much lower levels in the southern and central residential areas of the plume and no TCE and only very low PCE levels were found in soil gas samples collected from the northern residential area of the plume. The southern, the central and the northern residential portions of the plume lie in areas where, historically, high TCE concentrations have been reported in groundwater samples. In most instances, PCE concentrations in groundwater samples collected from these areas have been either non-detect or detected at concentrations below the drinking water standards. Historically, PCE levels in groundwater samples collected from the northern residential areas have exceeded the drinking water standard only twice, once during the 1990-1993 time period and once during the 1994-1999 time period.

- Chloroform was detected at a concentration of 0.23 µg/L in the groundwater collected from monitoring well MW-02 during the 2002 Field Investigation. Chloroform was also detected during the 2000 RI at a concentration of 0.9 µg/L in residential well RW-08. The 2002 chloroform concentration exceeded the corresponding TACO and WQCAL values but was below the corresponding MCL of 100 µg/L. The 2000 chloroform concentration slightly exceeded the TACO value. Chloroform concentration in sediment sample SED-1 (a background sample) exceeded the most conservative SQCAL value of 0.4 µg/kg. Chloroform was also detected in the soil gas samples collected from the residential areas of the groundwater plume. Chloroform concentrations exceeded the most conservative target RBC in soil gas samples collected from the central and southern residential areas of the groundwater plume. However, because chloroform was only detected at low levels in groundwater at one location in the residential area; and because chloroform was also detected in the field blank sample; and, considering potential contributions by extraneous sources such as common household disinfection products, chloroform and other trihalomethanes detected in the public water supply which is discharged into septic systems, and the disinfection of private wells with chlorine bleach or tablets, chloroform does not appear to be site-related.

- During the 2000 RI, acetone was reported in 18 of the groundwater samples collected from the CPT wells, and in two samples collected from the residential wells. During the same time period, acetone, a common laboratory contaminant, was also detected in field blank samples at concentrations up to 12 µg/L, suggesting that some of the groundwater detections may be due to laboratory contamination. Acetone was not reported in any samples collected during the April 2002 Investigation. It was also not detected in any sediment and surface water samples collected during the 2000 and 2002 investigations. The U.S. EPA has not established an MCL or an Ecotox value for acetone, however the TACO value has been established at 700 µg/L. Acetone has not been reported in any groundwater samples at concentrations that exceed the TACO value.

Acetone was also detected in soil gas samples at concentrations that did not exceed the most conservative target RBC and therefore, presents minimal risk to human health via the vapor intrusion pathway.

- During the 2000 RI, methylene chloride was reported in one groundwater sample collected from CPT-03. This reported value was well below the MCL and TACO value of 5 µg/L. It is also below the WQCAL value of 98 µg/L. No U.S. EPA Ecotox value has been established for this compound. To date, methlylene chloride has not been reported in any sediment and surface water samples.

  Methylene chloride was also detected in soil gas samples at concentrations that did not exceed the most conservative target RBC. Therefore, methylene chloride presents minimal risk to human health via the vapor intrusion pathway.

- During groundwater activities conducted from 1994-1999, 1,1-DCA concentrations were reported in several groundwater samples collected from monitoring wells. During the 2000 RI, 1,1-DCA was reported in a groundwater sample collected from CPT-11 which is located along Route 251 south of the apparent source area. During the 2002 Investigation, 1,1-DCA was reported in groundwater samples collected from monitoring wells MW-01A, MW-03, MW-105S, and MW-105D. Concentrations reported ranged from 0.19 µg/L to 0.39 µg/L. 1,1-DCA was not reported in any sediment and surface water samples. The soil gas samples collected during the May 2002 air investigation were not analyzed for 1,1-DCA. The reported 1,1-DCA groundwater concentrations were significantly lower than the TACO and Ecotox values. No MCL or WQCAL values have been established for this constituent.

- The compound 1,1-DCE was reported in several monitoring well samples collected during groundwater sampling activities conducted from 1994-1999. 1,1-DCE was also reported during the April 2002 Investigation in groundwater samples collected from MW-01A and MW-03 at estimated concentrations ranging from 0.16 to 0.2 µg/L. None of the reported 1,1-DCE concentrations exceeded the MCL and TACO value of 7 µg/L but were below the respective WQCAL value of 11,600 µg/L. U.S. EPA Ecotox value has not been established for this compound. 1,1-DCE was not reported in any of the groundwater samples collected during the 2000 RI. 1,1-DCE was also not reported in any sediment and surface water samples. The soil gas samples collected during the May 2002 air investigation were not analyzed for 1,1-DCE.

- The compound 2-butanone was detected in one groundwater sample during the 2000 RI. It was reported in CPT-05 at a concentration of 16 µg/L. 2-Butanone is a common laboratory contaminant and was also detected in field blank samples at concentrations up to 12 µg/L during the 2000 RI, suggesting that the detections may have been due to laboratory contamination. 2-Butanone was not reported in any of the groundwater samples collected during the April 2002 Investigation. With the exception of the WQCAL criteria (7,200 µg/L), no other criteria have been established for 2-butanone. The 2-butanone concentration reported in CPT-05 was significantly lower than its WQCAL criteria. 2-Butanone was also detected in sediment sample SD-04 at a concentration of 3 µg/kg, and in soil gas samples at concentrations that were below the most conservative target RBC, indicating minimal risk to human health via the vapor intrusion pathway.

- Cis-1,2-DCE was reported in several monitoring well samples collected during groundwater sampling activities conducted from 1994 to 1999. During the 2000 RI, cis-1,2-DCE was reported in groundwater samples collected from CPT-01, MW-105S, and MW-105D, and one residential well. The cis-1,2-DCE concentrations reported during this period ranged from 1 µg/L to 2 µg/L. During the 2002 investigation, cis-1,2-DCE concentrations were reported in groundwater samples collected from MW-01A, MW-03, MW-105S, and MW-105D at concentrations ranging from 0.16 µg/L to 0.2 µg/L. None of the cis-1,2-DCE concentrations reported in 2000 or 2002 exceeded the MCL or TACO value of 70 µg/L as well as the WQCAL value of 200 µg/L. The U.S. EPA Ecotox value for this constituent has not been established. Cis-1,2-DCE was not detected in any soil gas samples, sediment, and surface water samples collected to date.

- The compound 1,1-TCA was reported in several monitoring well samples collected during groundwater sampling activities conducted from 1994-1999. During the 2000 RI, 1,1,1-TCA was reported in groundwater samples collected from four CPT locations including CPT-01, CPT-3, CPT-10, and CPT-11 at concentrations ranging from 0.7 to 3 µg/L; from six monitoring wells including MW-103D, MW-104S, MW-104D, MW-105S, MW-105D, and MW-112 at concentrations ranging from 1 to 3 µg/L; and from six residential wells at concentrations ranging from 1 to 5 µg/L. During the 2002 Investigation, 1,1,1-TCA was reported in groundwater samples collected from monitoring wells MW-01A, MW-02, MW-03, MW-103S, MW-103D, MW-104S, MW-104D, MW-105S, MW-105D, and MW-109D at concentrations ranging from 0.29 µg/L to 2.4 µg/L. None of the 1,1,1-TCA concentrations reported in 2000 or 2002 exceeded any of the evaluation criteria.

  1,1,1-TCA was not detected any sediment or surface water sample collected to date. Although 1,1,1-TCA was detected in all soil gas samples, reported concentrations were below the most conservative target RBC. Therefore, 1,1,1-TCA presents minimal risk to the human health via vapor intrusion pathway.

- During the 2000 RI, benzene was reported in groundwater samples collected from CPT-09 and CPT-12. In CPT-09, benzene was detected at concentrations of 0.5 µg/L and 0.6 µg/L in samples collected from depths of 35 feet and 88 feet bgs, respectively. In CPT-12, benzene was detected at a concentration of 0.5 µg/L in a sample collected from a depth of 81 feet bgs. All reported concentrations were below the lowest available groundwater and ecological criteria. During the 2000 RI, benzene was reported in the background sediment sample SED-4 at a concentration that was below the lowest available groundwater and ecological evaluation criteria. Benzene has not been detected in any residential well samples, monitoring well samples, and surface water samples collected during the 2000 RI and the 2002 Investigations. Benzene was also detected in soil gas samples at concentrations exceeding the most conservative target RBC, suggesting that benzene may be site-related.

  Historically, benzene has not been identified as a major groundwater contaminant at the Evergreen Manor site. Benzene has only been detected at low levels (maximum concentration of 0.6 µg/L) in three groundwater samples from two CPT locations (2 samples from CPT-09 and one sample from CPT-12). These CPT samples were collected at temporary roadside locations while traffic was present, suggesting the possibility that the detected benzene may have been related to vehicle exhaust. Given the number of groundwater samples collected across the site and the infrequent benzene detections in distant sampling locations (>100 feet), the likelihood of benzene migrating from groundwater into indoor air of the target residences is minimal. However, elevated benzene levels (greater than the target RBC) in some of the soil gas samples indicate that some of the benzene may be site related, since groundwater at the water table/vadose zone interface has not been adequately characterized within the residential area. Before concluding whether or not benzene is site related, due consideration must also be given to the relationship between benzene detections in soil gas samples and extraneous sources such as emissions. Given the known data gaps/limitations, the origin of benzene in air samples remains uncertain.

- During the 2000 RI, toluene was detected in 75 samples collected from CPT sampling locations and nine samples collected from residential well locations at concentrations ranging from 0.5 to 3 µg/L. Toluene only exceeded the most conservative WQCAL value of 0.8 µg/L. These exceedances were primarily observed in CPT and residential well samples. During the 2000 RI investigation, toluene was also detected in method and field blanks at concentrations of up to 2 µg/L, suggesting contamination via extraneous sources. Toluene was also detected in the sediment sample SD-06 collected during the 2002 Investigation and in sediment sample SED-4, a background sediment sample, collected during the 2000 RI at concentrations that were below the lowest available groundwater and ecological evaluation criteria. Toluene was not reported in any surface water samples. Toluene was also detected in all soil gas samples at concentrations that were below the most conservative target RBC, indicating minimal risk to human health via the vapor intrusion pathway.

- During the 2000 RI, ethylbenzene was detected in a groundwater sample collected from CPT-09 at a concentration of 0.6 µg/L which is below the lowest available groundwater and ecological criteria. Ethylbenzene was not detected in any sediment and surface water samples collected during the 2000 and the 2002 Investigations. Ethylbenzene was also detected at concentrations exceeding the most conservative target RBC in several soil gas samples collected during the 2002 air sampling investigation, suggesting that ethylbenzene may be site-related. However, given the number of groundwater samples collected across the site, the location of detected ethylbenzene in groundwater with respect to target residences, and the general lack of detected ehtylbenzene in groundwater, the likelihood of ethylbenzene migrating from the groundwater into area residences is minimal. But the presence of ethylbenzene at significant levels in soil gas indicates that ethylbenzene may be site related, since groundwater at the water table/vadose zone interface has not been adequately characterized within the residential area. Before concluding whether or not ethylbenzene is site-related, due consideration must also be given to the effect of extraneous sources such as emissions from vehicles driven in and out of the attached garages and gasoline products stored in the garages of homes. Based on conflicting groundwater and air data, it is uncertain whether vapor intrusion pathway for ethylbenzene is complete at the Evergreen Manor site.

- Xylenes were detected in groundwater in CPT-02 (three samples), CPT-06, CPT-09, and CPT-11 at concentrations ranging from 0.5 µg/L to 0.7 µg/L. These concentrations were below the lowest groundwater and ecological evaluation criteria available. Xylenes were detected in all the soil gas samples at concentrations that did not exceed the most conservative target RBC, indicating minimal risk to human health via the vapor intrusion pathway. Xylenes were also not detected in any sediment or surface water samples.

- During the 2000 RI, Freon 113 was reported in groundwater samples collected from MW-103S and MW-103D (and the duplicate sample) at concentrations ranging from 2 µg/L to 300 µg/L. During the 2002 Investigation, Freon 113 was reported in groundwater sample collected from MW-103D and MW-107D at concentrations of 30 µg/L and 6.7 µg/L, respectively. These detections were found in the upgradient wells, but not in the groundwater samples collected within the residential subdivisions. The only evaluation criteria established for this constituent is the WQCAL value which is 580 µg/L. Freon 113 was also detected in the background sediment sample SD-01 collected during the 2002 Investigation. The reported concentration was well below the lowest available evaluation criteria. Freon 113 was also detected in all the soil gas samples at concentrations that did not exceed the most conservative target RBC and therefore, presents minimal risk to human health via the vapor intrusion pathway.

- To date, methyl acetate has only been reported in two sediment samples, SED-1 and SED-5, collected during the 2000 RI. The reported concentrations were well below the lowest available evaluation criteria.

Figure 1-7 presents the 2000 RI groundwater data for chlorinated VOCs. The results of 2002 Investigation are shown in Figure 1-8. Sediment and surface water data collected during 2000 and 2002 investigations are presented in Figure 1-9. The above figures also show the results of evaluation of the 2000 and the 2002 data against evaluation criteria.

In an effort to evaluate trends in the TCE and/or PCE concentrations reported in the groundwater throughout the Evergreen Manor site with time, locations where multiple samples have historically been collected, were identified and groundwater sample results assembled during the development of the GDER. These locations and the corresponding TCE and PCE data are shown in Figures 1-10 and Figure 1-11, respectively.

As shown in the data plots provided in Figure 1-10, with few exceptions, the TCE concentrations are either stable, or have declined throughout the historical plume boundaries. TCE concentrations tend to be decreasing in the upgradient portion of the plume, north of Straw Lane, and tend to be stable in the downgradient part of the plume. In nearly all cases, the TCE reported in the groundwater samples have declined to concentrations below the MCL (5 μg/L). These observations coupled with the site hydrogeological conditions suggest that the plume is shrinking, most likely due to advective transport.

As previously described, the volume of PCE data is not consistent with that reported for TCE. However, even with the amount of PCE data, it is evident that PCE concentrations are stable at a minimum, and in most cases, are declining throughout the Evergreen Manor site. This is evident in

Figure 1-10, where with the exception of MW-104, MW-105, and MW-106, and in the vicinity of Blue Spruce Drive and Straw Lane, concentrations have shown a steady decline. The area where PCE concentrations are not declining is confined to the central portion of the plume, where limited groundwater monitoring locations are present. As a result, an accurate depiction of the nature of the PCE plume is not available.

In general, the VOC concentrations reported from the 1990 through 2002 investigation have either declined or have remained stable. The TCE and PCE concentration trends depicted suggest that both TCE and PCE are undergoing natural decay that follows first-order kinetics. In other words, the decay rate is directly proportional to the contaminant concentration and slows with a decline in the contaminant concentration. For example, the TCE concentration associated with MW-105D reduces from 15 µg/L at time t=0 (HRS sampling event in 1994) to 3 µg/L at time t=5 years (2000 RI sampling event), representing approximately 80% decline over 5 years. The concentration further declines from 3 µg/L at time t=5 years to 2.8 µg/L at time t=7 years (April 2002 sampling period), a reduction of only 7% in 2 years.

Assuming that the observed contaminant attenuation rate continues in the future, it was projected that the TCE concentration of 7.2 µg/L, observed in monitoring well MW-03 in 2002, could decline to less than 5 µg/L in approximately 1.5 years. This time period was derived by assuming, conservatively, that TCE decay rate will follow the TCE attenuation trend observed in monitoring well MW-105D described above. Similarly, it was projected that by following the PCE attenuation rate observed in monitoring well MW-103S, the 2002 PCE concentration of 5.9 µg/L, observed in monitoring well MW-03, could decline to less than 5 µg/L in approximately 3 years.

Results of the foregoing first order kinetics are consistent with the results of the RI which concluded that constituent concentrations, will continue to decline, primarily due to dispersion, advection, and possibly due to biodegradation, and ultimately decline below MCLs. During the 2000 RI, the BIOSCREEN model was used to estimate the time frame during which COPC concentrations would decline below MCLs. The model results predicted that TCE concentrations would reduce below the MCLs in about 6 years after the RI, (approximately 2006). The same model predicted that PCE would reduce below the MCLs in about 15 years after the RI, (in about 2015).

Although the expected TCE attenuation rate predicted by the BIOSCREEN model is similar to the attenuation rate predicted by the kinetic model, the PCE attenuation rates predicted by the two models vary significantly. Apparently, the continuing decline in PCE concentrations, observed during the 2002 investigation, point to an accelerated decline in PCE concentrations.

The GDER also noted an overall decrease in the size of contaminant plume over time. An overall decrease in the size of the contaminant plume, favorable site conditions, contaminants amenable to natural attenuation substantiated by overall decrease in concentrations, presence of PCE upgradient possibly breaking down to TCE downgradient, and presence of numerous daughter products at low levels throughout the plume and other site-specific data presented in this report, appears to indicate that monitored natural attenuation (MNA) is a likely candidate for use as the cleanup option for the Evergreen Manor site.

Additional discussions regarding the nature and extent of groundwater contamination can be found in Sections 4 and 5 of the GDER, Revision 1 (WESTON, 2003). Additional details regarding the air sampling results and their correlation with groundwater results are presented in the Air Sampling Report, Revision 3 (WESTON, 2003).

1.5.3 Sources of Contamination

The GDER noted that the horizontal extent of VOC contaminated groundwater throughout the Evergreen Manor site has been defined to varying degrees using all available data and information for evaluation, however the precise source of these impacts has never been adequately determined. Early investigations, including well installation, soil vapor surveys, and groundwater sampling, have indicated that the source(s) was likely present in the industrial area surrounding the intersection of Rockton Road and Route 251. Regal-Beloit, AAA Disposal (property now owned by Waste Management) and Ecolab had waste disposal areas on their property near Route 251 and Rockton Road that were all, to some degree, "closed" under IEPA oversight. Information submitted to IEPA by Waste Management, Regal-Beloit and Ecolab during the mid-1990s indicates that the likely sources of the groundwater contamination at the Evergreen Manor site include:

- A landfill at former AAA Disposal System that was covered with soil and granted closure by IEPA in 1977. In 1990, 1,380 cubic yards of material was also excavated from this property and removed by the current property owner, Waste Management. Soil samples collected from the site contained low levels of TCE (13 µg/kg), 1,1-DCA (8 µg/kg), cis-1,2-DCE (15 µg/kg) and PCE (6.8 µg/kg), and higher levels of benzene (1,000 µg/kg), toluene (940 µg/kg) and xylene (7,300 µg/kg). Samples Waste Management collected from the nearby Schewbke property in 1990 also contained PCE at 40 µg/kg.

- Wastewater discharged to a septic field and 5 underground storage tanks at Regal-Beloit which were closed under RCRA in 1987. Soil samples collected from the site contained low levels of TCE (7 µg/kg) and 1,1,1-TCA (2 µg/kg).

- A wastewater lagoon at Ecolab that was removed under IEPA oversight in 1979. MW-103, installed immediately downgradient of Ecolab had the highest concentrations of PCE (40 µg/L) and 1,1,1-TCA (16 µg/L).

Further evaluation during the 2000 RI, including attempts at fracture trace analysis, limited additional intrusive work (CPT), and sampling of existing monitoring wells, did not substantially change the conclusion that the source(s) was likely located near the intersection of Rockton Road and Route 251. Other than sampling of selected existing monitoring wells, no additional efforts were conducted to further evaluate the source(s) area during the 2002 Investigation. Thus, to date, the specific source(s) of chlorinated VOC groundwater contamination remains uncertain. Additional discussions regarding sources of contamination at the Evergreen Manor site can be found in Sections 2 and 6 of the GDER, Revision1 (WESTON, 2003).

1.5.4 Data Gaps and Uncertainties

The GDER noted several uncertainties associated with a number of identified factors related to the assessment and evaluation of the analytical data collected at the Evergreen Manor site between 1990 and 2002. Factors identified with associated uncertainty and data gaps included the following:

- Uncertainty associated with identification of the source area.
- Uncertainty associated with hydrogeologic characteristics of the study area.
- Uncertainty associated with variation in investigation objectives, sampling frequency, parameter analysis, and sampling methods over time.
- Uncertainty associated with the horizontal and vertical extent of the plume.
- Uncertainty associated with the vapor migration pathway
- Uncertainty associated with evidence of natural attenuation processes.
- Uncertainty associated with impact to nearby municipal well systems.

Detailed discussions regarding the uncertainties and data gaps identified during evaluation of groundwater, surface water, sediment, and soil gas data collected between 1990 and 2002 can be found in Section 6 of the GDER, Revision 1 (WESTON, 2003). Relevant portions of Section 6 are summarized below.

- The general trend observed during the evaluation of previous studies indicates an apparent decrease in the contaminant concentrations over different time frames. This trend suggests that the source(s) may not represent a continuing source of groundwater contamination. Questions remain, however, such as whether past releases were in the form of dense non-aqueous phase liquids (DNAPL). These may have resulted in very deep portions of the aquifer being contaminated, and shallower portions only exhibiting patterns of contamination consistent with that of residual contamination. Due to the uncertainty and data gaps identified, data may be not be sufficient to adequately determine the location and nature of the source(s). Thus, the source(s) of contamination, whether multiple sources, extraneous sources, point source or continuing source, remain unknown, and additional effort may be warranted to address this issue. The level of effort will necessarily be based on anticipated remedial approaches.

- A certain amount of uncertainty remains with respect to the current horizontal and vertical extent of the Evergreen Manor plume, and the remaining contaminant concentrations within the plume. This is especially true for shallow groundwater which, for the most part, has not been characterized within the residential area, but which poses the greatest risk to residents via the vapor intrusion pathway. Similarly, the location of the center of the plume, horizontally and vertically, is also unclear.

- Although same-location sampling, where available, shows significant decreases in contaminant concentrations over time, actual concentrations in other areas of the plume could be somewhat higher than those indicated by the current monitoring well network and CPT sampling, which only provide limited horizontal and vertical data points. Additionally, these data points may not be located in the area and/or zones of highest contamination.

- This uncertainty is relevant in terms of where and at what levels chemicals may migrate into homes via the vapor intrusion pathway; whether current or future well supplies are or may be impacted; and whether any chemicals are migrating under and beyond the Rock River.

- The hydrostratigraphy of the shallow contaminated sand and gravel aquifer has only been characterized up to a maximum depth of approximately 100 ft. bgs, and not at all locations within the estimated plume boundaries.

- Although attempts to map groundwater flow across the site conclude the overall lateral groundwater flow direction is towards the Rock River, insufficient spatial data points are available to evaluate local variation in groundwater flow patterns (direction and velocity). This is especially true with regards to vertical flow characteristics across the site.

- The presence and magnitude of vertical gradients in the vicinity of the Rock River has not been documented; therefore, insufficient evidence is currently available to state that all contaminated groundwater associated with the Evergreen Manor VOC plume discharges to the Rock River, or that alternately, an underflow condition exists. In the event that the VOC contaminated groundwater observed at the site is present at sufficient depths to be influenced by the more regional flow regimes, it is possible that contaminants could be migrating beneath the Rock River.

- Temporal data on water levels, recharge from precipitation, geochemical conditions, flow direction and other hydrogeological data are also limited. This limits the full evaluation of the sources of variability in VOC concentrations and distributions. These temporal data are needed to more effectively assess the fate of contaminants in the groundwater.

- Some of the highest levels of PCE and TCE concentrations in soil gas were found in an area with lowest levels of groundwater contamination. It is possible that contaminants that have not been characterized or quantified may be present near the water table surface or in the vadose zone in these areas, and a vapor migration potential may exist there.

1.5.5 Additional Characterization

The GDER noted that monitored natural attenuation (MNA) may be a likely candidate for use as the remedial option for the Evergreen Manor site. In the event that MNA is determined suitable for implementation as a cleanup remedy, it is equally important to have an appropriate monitoring network to verify and demonstrate that the cleanup goals established are being met in an appropriate time frame. In order to help identify areas where vapors may collect or be channeled, even if groundwater concentrations are low, the GDER also recommended that extent of soil gas and shallow groundwater contamination be characterized throughout the subdivisions during the pre-design phase. The GDER recommended that the soil gas and indoor air monitoring program target a statistically significant number of homes. The initial sampling should target homes in areas that, historically, have had the highest levels of groundwater contamination (e.g., those along the centerline of the plume), homes in areas where relatively lower level of contamination has been observed, and homes that lie outside the plume. Specifically, the GDER recommended the following additional characterization activities during the pre-design phase prior to implementing any remedial alternative:

- Sample all private wells within the plume site boundary (as determined by the historical maximum extent of VOCs) and in nearby areas to confirm that these wells are not impacted. This would include sampling approximately nine locations along Metric Road, 19 locations along East Rockton Road, 12 locations along Route

251/2nd Street, 19 locations along Degroff, four locations along McCurry, and 10 locations along Stamford Lane and Waltham Road.

- The GDER noted that the current monitoring well network may not be appropriately located to determine accurate groundwater flow direction. And therefore recommended confirming the groundwater flow across the site to help identify areas where groundwater contaminants may remain. The GDER recommended the installation of 11 piezometers to supplement groundwater elevation data from the existing groundwater monitoring well network.

- Evaluate whether existing monitoring wells are appropriately located to monitor the remaining groundwater contamination, and identify the extent and concentrations of the remaining groundwater contamination. The GDER suggested vertical profiling at existing well locations, with additional vertical profiling in nearby areas to confirm the extent of any remaining contamination. Groundwater flow directions and private well sampling can also be used to help target areas where groundwater contaminants may remain. Vertical profiling was suggested in the vicinity of the following areas:

  - MW-103, MW-107, MW-108, MW-109 (10 locations)

  - Degroff Street, MW-101, and unsampled CPT-07, CPT-08 and CPT-13 (6 locations)

  - Between CPT-05 and CPT-10 and CPT-10 and CPT-06 (4 locations)

  - In the subdivisions to determine current concentrations in the center of the plume and to confirm plume boundaries (15 locations)

  - On the other side of the Rock River to confirm there is no underflow and contaminant transport to the other side of the Rock River (5 locations)

- The actual number of vertical profiling locations could be more or less and would depend on the results of initial vertical profiling locations.

- Use the results of the groundwater elevation data, vertical profiling and residential well sampling to identify horizontal and vertical areas where additional monitoring wells are needed for any long-term monitoring programs. Approximately 10 additional shallow wells and 10 additional deep wells may be needed. The actual number of monitoring wells needed would depend on the results of the pre-design investigations.

- Soil gas and shallow groundwater sampling at approximately 50 locations within the subdivisions (20% of homes) to determine the nature and extent of any shallow groundwater and soil gas contamination and target approximately 25 homes for a long-term vapor monitoring program. The actual number of locations could be more or less and would depend on the results of initial soil gas and groundwater results. Approximately three soil gas samples would be collected at each sampling location - one just above the water table, one consistent with the bottom of the home's foundation (about 8 ft) and one in between. Approximately two groundwater samples should be collected at each location - one at the water table and one in the interval below.

- Soil sampling may be needed at locations where groundwater sample results do not correlate well with soil gas results to determine whether there are any homeowner-related spills.

- Septic systems, used by most, if not all of the Evergreen Manor subdivision residents, may be a point-source of certain contamination (e.g., use of chemicals to unclog a drain). Based on the results of the soil gas and shallow groundwater characterization, it may be necessary to conduct additional soil, soil gas and shallow groundwater samples in the vicinity of selected septic systems to determine whether the septic system is a source of contamination. However, it should also be noted that, prior to the municipal well-hookup, household water obtained from contaminated private well supplies was discharged to septic systems.

- Based on the results of the soil gas and shallow groundwater sampling, target approximately 25 homes for soil gas and indoor air monitoring. Monitoring would include 24-hour indoor air samples at two to three locations per home and 24-hour samples at four soil gas locations at foundation depth per home four times a year (spring, summer, fall and winter). One of the indoor air samples could be collected in or near an attached garage to evaluate whether any BTEX compounds are homeowner-related or site-related. Soil samples could also be collected for VOC analysis at each soil gas location to determine whether there were any homeowner-related spills during sampling period. Shallow groundwater samples would also be collected at about 10 locations each sampling period to correlate groundwater concentrations with soil gas findings. The soil gas and indoor air monitoring should continue for two years until baseline indoor air and soil gas concentrations are established. The soil gas and indoor air monitoring would continue until it is confirmed that vapor intrusion via soil gas is not a threat.

SECTION 2

IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents the identification and screening of technologies for the Evergreen Manor Site. This section includes (1) the development of RAOs, (2) presents general response actions, (3) identifies potential technologies based on RAOs, and (4) screens the technologies by effectiveness, implementability, and cost.

2.1 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

RAOs consist of medium-specific goals for protecting human health and the environment. In accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (U.S. EPA, 1988), RAOs should specify constituents of human health concern (COCs), constituents of ecological concern (COECs), exposure pathways and receptors, and acceptable constituent levels or ranges of levels for each exposure pathway. COCs are the COPCs that were identified in the RI Report and exceed the RAOs. RAOs for protecting human receptors should express both a contaminant level and an exposure route, rather than contaminant levels alone, because protectiveness may be achieved by reducing exposure (i.e., by engineered or institutional controls), as well as by reducing contaminant levels. Alternatively, environmental objectives should be expressed in terms of the medium of interest and target contaminant levels, whenever feasible, since RAOs developed for protection of environmental receptors typically seek to preserve or restore a resource.

In developing the RAOs, due consideration was given to the requirements established under the NCP. In addition, the OSWER Directive 9355.7-04 (U.S.EPA, 1995), which provides guidance in determining RAOs, was used in developing the RAOs for this site. One of the major points of this directive is that RAOs developed during the RI/FS process should reflect reasonably anticipated future land use or uses.

2.1.1 Exposure Pathways and Receptors

The identification of exposure pathways and receptors is important in developing RAOs because protectiveness to human health and the environment may be achieved by reducing exposure (such as containment or access limitations).

2.1.1.1 Groundwater

The baseline human health and ecological risk assessments included in the RI (WESTON, 2001) evaluated carcinogenic and noncarcinogenic risks associated with exposure to groundwater contaminants at the Evergreen Manor Site under a no-action alternative (i.e., in the absence of remedial [corrective] action). Information and data collected during the RI served as the basis for the RA; however, since the groundwater contaminant concentrations detected in the samples collected during the April 2002 investigation were similar or less than the concentrations detected in the RI samples, the relative risk posed by the contaminants at the site is assumed to remain unchanged. Based on current site conditions and site ownership, the baseline human health risk assessment (HHRA) evaluated residential users and commercial/industrial users as the primary receptor groups at this site. Residential land use was considered as the future use for the site. The maximum detected concentrations were used as the exposure point concentrations, combining data from the residential wells, monitoring wells, and CPT sampling locations since no identifiable source was found. Potential exposure to site groundwater was estimated individually for adult and child residents and adult commercial/industrial workers. While different exposure assumptions were used for each age group and exposure scenario, the same toxicity criteria (i.e., slope factors and reference doses) were applied to all population subgroups evaluated.

Baseline Human Health Risk Assessment

A constituent was identified as a COPC, and was evaluated in the baseline HHRA if one or more of the following conditions were met ;

- The constituent was positively detected in at least one sample in a given medium, including (a) a constituent with no qualifiers attached (excluding samples with unusually high detection limits) and (b) a constituent with qualifiers attached that indicate known identities but unknown or estimated concentrations (e.g., J-qualified data).

- The constituent was detected at levels significantly elevated above levels of the same constituent detected in associated blank samples.

- The constituent was detected at levels above Region IX soil risk-based Preliminary Remediation Goals (PRGs) (U.S. EPA, 2000a), which are associated with a cancer risk of 1E-06 (one-in-one-million) and a systemic HQ of 1. In order to provide a more conservative screening and to account for similar toxic endpoints among noncarcinogenic compounds, a HQ of 0.1 was used in screening noncarcinogenic chemicals. A risk level of 1E-07 was used in screening carcinogenic chemicals based on U.S. EPA guidance (U.S. EPA, 1993). Where risk-based concentrations are available for cancer and noncancer endpoints and both ingestion and inhalation exposure routes, the lower (i.e., most stringent) value was used for the screening comparison.

Toxicity criteria for identified COPCs were obtained from the following sources:

- Integrated Risk Information System (IRIS) (U.S. EPA, 2000b); and
- Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1995a).

If toxicity criteria were not available from these sources, toxicity criteria presented in the Region IX PRG Tables (U.S. EPA, 2000a) were used.

Carcinogenic and non-carcinogenic risks were evaluated for each chemical COPC through each exposure route of concern, and for all COPCs through all exposure routes combined. Carcinogenic risks for COPCs were evaluated by using the exposure point concentrations (EPCs) to calculate the reasonable maximum and the representative average probabilities for developing cancer from exposure to the COPCs. The EPCs were the lesser of the 95th percentile upper confidence limit average (UCL_{95}) concentration or maximum detected concentration for each constituent. The probabilities of developing cancer from exposure to the COPCs were then compared to the U.S. EPA's acceptable risk range of 1E-06 to 1E-04. Non-carcinogenic effects were evaluated by developing a hazard quotient (HQ) for each noncarcinogenic constituent. The HQs for constituents that targeted certain organs were then summed to obtain a hazard index (HI) for the effected organ. The HQs and HIs for each scenario were compared to unity. If the HQ for any constituent or the HI for any organ exceeded the value of one, adverse, noncarcinogenic health effects are considered to be possible.

Under the residential (current/future) exposure scenario, it was assumed that residents use on-site groundwater as a potable water supply, potentially being exposed to chemical COPCs in groundwater through ingestion, dermal absorption while bathing, and inhalation of volatiles.

The potential chemical cancer risk estimates associated with the residential scenario are presented in Table 2-1. The chemical cancer risk ranged from 4.6E-06 to 1.9E-05. PCE had an individual reasonable maximum exposure (RME) cancer risk estimate exceeding 1.0E-06 via ingestion, while

TCE, PCE, and chloroform had individual RME cancer risk estimates greater than 1.0E-06 via inhalation.

The estimates of the potential for adverse, noncarcinogenic health effects associated with the residential scenario are presented in Table 2-2. The total HI (all COPCs, all target effects, all exposure routes) ranged from 1.4 to 1.4 for the adult resident and from 3.7 to 3.8 for the child resident. Chloroform was the only COPC with an individual HQ value (via inhalation) exceeding one. Acetone, PCE, and methylene chloride effect the same target organ (liver) as chloroform. These COPCs with the same target organ/effect had a total HI (based on effect) greater than one only when combined with chloroform.

Under commercial/industrial worker (current/future) exposure scenario, it is assumed that land located within the Evergreen Manor Site are used for commercial and industrial purposes. Commercial/industrial receptors were assumed to use on-site groundwater as a potable water supply, potentially being exposed to chemical COPCs in groundwater through ingestion, dermal absorption while bathing, and inhalation of volatiles.

The potential chemical cancer risk estimates associated with the commercial/industrial scenario are presented in Table 2-1 For this future groundwater pathway, the chemical cancer risk ranged from 2.0E-06 to 6.9E-06. PCE had an individual RME cancer risk estimate exceeding 1.0E-06 via ingestion and dermal absorption, while chloroform had an individual RME cancer risk estimate exceeding 1.0E-06 for inhalation.

The estimates of the potential for adverse, noncarcinogenic health effects associated with the industrial/commercial scenario are presented in Table 2-2. For the future groundwater pathway, the total HI ranged from 0.97 to 0.99. No COPCs with the same target organ/effect had a total HI (based on effect) greater than one in any of groundwater samples.

Ecological Risk Evaluation

Aquatic biota potentially inhabiting the Rock River and Dry Creek are the primary ecological receptors at the Evergreen Manor Site. Other ecological receptors potentially exposed to contaminated groundwater from the Evergreen Manor Site include animals and plants common to rivers and streams of northwestern Illinois. Due to the apparent hydrologic connection between the contaminated shallow outwash aquifer beneath the Evergreen Manor Site and the downgradient Rock River and in order to evaluate the potential impacts of chemical constituents in groundwater on ecological receptors, groundwater analytical results (monitoring well, temporary CPT well, and residential well data) obtained during the 2000 RI and the 2002 Investigation were compared to the following ecological criteria:

- Lowest available U.S. EPA Ecotox Thresholds.
- Most conservative Water Quality Criteria and Guidelines for the Protection of Aquatic Life (WQCAL) obtained from *the Compendium of Environmental Quality Benchmarks* published by Environment Canada.

For similar reasons, the sediment data collected during the 2000 RI and 2002 Investigation were compared to the following criteria:

- Lowest available U.S. EPA Ecotox Thresholds.
- Most conservative Sediment Quality Criteria and Guidelines for the Protection of Aquatic Life (SQCAL) obtained from *the Compendium of Environmental Quality Benchmarks* published by Environment Canada.

These two criteria and the corresponding values are included in Table 1-1. Since no chemical constituents were detected in surface water, surface water data were not evaluated against any ecological benchmarks/criteria. Chemical constituents which exceeded the aforementioned criteria are as follows:

- TCE and PCE concentrations reported in several residential wells, monitoring wells, and temporary CPT sampling locations exceeded their respective WQCAL values. In particular, PCE was reported in groundwater samples collected from monitoring well MW-103S at concentrations of 9 μg/L and 5.9 μg/L during the 2000 RI and the 2002 Investigation, respectively. These concentrations exceed the WQCAL value of 5 μg/L but are below the U.S. EPA's lowest Ecotox value of 120 μg/L. To date, PCE has not been detected in any sediment or surface water samples collected from the Rock River along the estimated discharge zone.

- During the 2000 RI and the 2002 Investigation, TCE was reported in several groundwater samples at concentrations that exceeded the WQCAL value of 1 μg/L. Some of these TCE concentrations also exceeded the U.S. EPA Ecotox value of 5 μg/L. To date, TCE has not been reported in any sediment or surface water samples collected from the Rock River along the estimated discharge zone.

- During the 2002 Investigation, chloroform was detected at a concentration of 0.23 μg/L in the groundwater sample collected from monitoring well MW-02. Chloroform was also detected during the 2000 RI at a concentration of 0.9 μg/L in the groundwater sample collected from residential well RW-08 (located near Wagon Lane and Straw Lane). The 2000 chloroform concentration exceeded its WQCAL value of 0.6 μg/L. No Ecotox value for chloroform has been established by the U.S. EPA. Chloroform in sediment sample SED-1 (a background sample) exceeded the most conservative SQCAL value of 0.4 μg/kg. Chloroform was not detected in any other sediment samples. Chloroform was also not detected in any surface water samples collected to date.

- During the 2000 RI, toluene was detected in 75 samples collected from CPT sampling locations and nine samples collected from residential well locations at concentrations ranging from 0.5 to 3 μg/L. Thus, in many cases, these concentration exceeded the most conservative WQCAL value of 0.8 μg/L. During the 2000 RI investigation, toluene was also detected in method and field blanks at concentrations of up to 2 μg/L, suggesting contamination via extraneous sources. Toluene was also detected in the sediment sample SD-06 collected during the 2002 Investigation and in sediment sample SED-4, a background sediment sample, collected during the 2000 RI at concentrations that were below the U.S. EPA Ecotox (670 μg/kg) and the SQCAL (890 μg/kg) values. Toluene has not been reported in any surface water samples. The 2000 RI toluene data are not presented in Figure 1-7, however, the data are depicted in Figures 4-7 and 4-10 of GDER, Revision 1 (WESTON, 2003).

Although, PCE, TCE, chloroform, and toluene were detected in groundwater at concentrations above WQCAL, they were not detected in any surface water samples collected to date. In sediment samples, only toluene was reported in sediment sample SD-6 located in an area which has the potential to be impacted by either site-related source materials which could have been discharged into the Dry Creek or contaminated groundwater which is likely discharging into the Rock River. However, the reported toluene concentration in this sample was well below the U.S. EPA Ecotox and SQCAL values. Based on the foregoing discussion, it appears that the contaminated groundwater, likely discharging to the Rock River, is not impacting surface water and sediment associated with the Rock River. However, since several chemical constituents were detected in groundwater at concentrations exceeding the WQCAL and since the contaminated groundwater has the potential to impact the surface water and sediment in the future, any remedial alternatives should include measures or appropriate contingencies to ensure that contaminated groundwater is not impacting surface water and sediment as the Evergreen Manor groundwater discharges into the Rock River.

2.1.2 Air (Vapor Intrusion Pathway)

A human health streamlined risk evaluation (SRE) was conducted using the air sample data collected during the May 2002 air sampling investigation. The SRE was conducted to determine whether there was evidence of migration of VOCs in groundwater contaminant plume into area homes via the vapor intrusion pathway, and whether there was evidence that any of these compounds could be found at highly elevated levels indoors. As discussed in the Air Sampling Report, Revision 3 (WESTON, 2003), COPCs, which included benzene, chloroform, ethylbenzene, methylene chloride, PCE, and TCE, were identified during the pre-SRE screening against risk-based concentrations (RBCs). Subsequently, these COPCs were evaluated for a potential human health risk during the SRE.

The result of SRE revealed that in indoor air at the four homes that were sampled, potential cancer risks for chemicals possibly related to the Evergreen Manor Site, ranged from 2.3×10^{-6} (two to three additional cases of cancer for every 1 million people similarly exposed) to 5.7×10^{-5} (five to six additional cases of cancer for every 100,000 people similarly exposed). These risks were within U.S. EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} (1 additional case of cancer for every 10,000 to 1 million people similarly exposed). These risks were primarily due to PCE and benzene. The overall potential cancer risk from all chemicals detected in the homes ranged from 1.1×10^{-4} to 1.3×10^{-5}. These risks were also within U.S. EPA's acceptable risk range.

Soil gas measurements were used to predict indoor air concentrations in order to determine if there was a potential for volatile chemical migration into residences in the selected Areas. When soil gas concentrations were modeled to predict indoor air concentrations, potential cancer risks due to TCE, PCE, and benzene ranging from 6.1×10^{-6} to 9.5×10^{-5} (almost 1×10^{-4}) were suggested. The potential cancer risks for only TCE and PCE ranged from 8.4×10^{-5} to 1.3×10^{-7}. Potential cancer risks from all chemicals ranged from 9.6×10^{-5} (almost 1×10^{-4}) to 9.7×10^{-6} (almost 1×10^{-5}). The predicted indoor air concentrations gave risk estimates that were within U.S. EPA's acceptable risk range, but suggested the need for additional indoor air measurements to confirm these predictions.

Additional details regarding air sampling results and their evaluation can be found in Sections 5 and 7 of the Air Sampling Report, Revision 3 (WESTON, 2003).

2.1.3 Preliminary Remediation Goals

Preliminary Remediation Goals (PRGs) were developed for the constituents of concern (COCs) identified at the Evergreen Manor Site. PRGs are acceptable contaminant levels for each chemical constituent and exposure route for a given environmental medium.

2.1.3.1 Groundwater

Groundwater screening levels were initially derived in the RI Report based on the most conservative (i.e., most stringent) risk-based cleanup values in order to illustrate the nature and extent of contamination at the site and identify the COCs. Based on the results of the RI and the April 2002 investigation, the only COCs at the site are PCE and TCE in the shallow groundwater. During the initial evaluation, chloroform was also identified as a COPC, however, because chloroform was only detected at low levels in groundwater at one location in the residential area; and because chloroform was also detected in the field blank sample; and, considering potential contributions by extraneous sources such as common household disinfection products, chloroform and other trihalomethanes detected in the public water supply which is discharged into septic systems, and the disinfection of private wells with chlorine bleach or tablets, chloroform does not appear to be site-related. As a result, PRG for chloroform was not established. The PRGs used to develop the RAOs for these COCs are based on chemical-specific ARARs and to-be-considered (TBC) criteria, which include risk-based concentrations (RBCs).

The basis for ARARs is cited in Section 121(d) of CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), which requires that Superfund-financed enforcement and federal facility remedial action to comply with all applicable or relevant and appropriate federal environmental or promulgated state environmental or facility citing laws, unless such standards are waived. "For the purposes of identification and notification of promulgated state standards, the term *promulgated* means that the standards are of general applicability and are legally enforceable" (NCP, 40 CFR 300.400[g][4]).

"Applicable requirements" are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site".

"Relevant and appropriate requirements," similar to applicable requirements, are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility citing law, that while applicable hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, addresses problems or situations specifically similar to those encountered at the CERCLA site that their use is well suited to the specific site.

In addition to the ARARs, advisories, criteria, or guidance may be identified as TBC for a particular contaminant or set of circumstances at a CERCLA site. As defined in 40 CFR 300.400(g)(3), the TBC category "consists of advisories, criteria, or guidance developed by U.S. EPA, other federal agencies, or states that may be useful in developing CERCLA remedies." Use of TBC criteria is discretionary rather than mandatory, as opposed to the use of ARARs, which is mandatory.

The identification and evaluation of the potential ARARs for the Evergreen Manor Site are presented in detail in Appendix A. There are three categories of ARARs: chemical-specific; location-specific; and action-specific. These categories are described in Appendix A. Chemical-specific ARARs were considered during the development of the PRGs.

In addition to the ARARs, RBCs from various sources were also used for developing the PRGs. RBCs are chemical concentrations in environmental media (i.e., soil, groundwater, etc.) that correspond to a fixed, acceptable risk under standard exposure scenarios. The RBCs are considered to be TBC criteria rather than ARARs. Since the COPCs identified at the site were present only in the shallow groundwater, PRGs only required development for PCE and TCE in groundwater.

Groundwater screening levels were developed by evaluating the applicable regulatory standards. These include the Illinois Environmental Protection Agency (IEPA) and the U.S. EPA groundwater quality standards. The IEPA standards are described in Title 35, Part 742 of the Illinois Administrative Code (35 IAC 742), entitled "Tiered Approach to Corrective Action Objectives" (TACO). Table E, *Tier I Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route*, of Appendix B of TACO lists all of the applicable groundwater quality standards. The U.S. EPA regulatory standards are the Maximum Concentration Levels (MCLs), which are incorporated into the Safe Drinking Water Act (SDWA) and are found in 40 CFR 141.61 - Maximum Contaminant Levels (MCLs) for Organic Contaminants (Integrated).

Both the TACO groundwater objectives and MCLs for both PCE and TCE are 5 µg/L, which has been determined to be the PRG value for each of these COPCs. During the RI and the April 2002 investigation, both PCE and TCE were detected at concentrations exceeding the PRG of 5 µg/L;

consequently, both PCE and TCE are considered to be COCs in the shallow aquifer at the Evergreen Manor Site.

Figures 1-7 and 1-8 show the extent of the chlorinated VOC detections in groundwater samples collected during the 2000 and 2002 investigations, respectively. These figures also show that only PCE and TCE exceeded their respective PRGs at only a few locations within the investigative area. However, since the exact source(s) has not been identified and a certain amount of uncertainty remains with respect to the current horizontal and vertical extent of the Evergreen Manor plume, and the remaining contaminant concentrations within the plume, the extent of contamination in the shallow aquifer at the Evergreen Manor Site is assumed to be equivalent to the area of the VOC detection plume that is based on 2000 and 2002 investigations.

2.1.3.2 Air (Vapor Intrusion Pathway)

PRGs for the air medium were developed from the most conservative risk-based concentrations (RBCs) obtained from two sources-U.S. EPA Region IX PRGs for ambient air (U.S. EPA, 2002a) and U.S. EPA Vapor Intrusion Guidance values (U.S. EPA 2002b). Further details regarding the RBCs and their use can be found in Sections 5 and 7 of the Air Sampling Report, Revision 3 (WESTON, 2003).

2.1.4 Remedial Action Objectives

Based on the COCs, the exposure pathways and receptors, and the PRGs developed for the COCs, the following RAOs were developed:

- Prevent people from using the contaminated groundwater as a drinking water supply until the groundwater is cleaned up to drinking water standards and acceptable cancer and non-cancer risk levels are achieved for TCE, PCE and any other site-related chemicals found during RD/RA.

- Return the groundwater to drinking water standards for TCE and PCE at all points throughout the aquifer within a reasonable time frame for the site.

- Return the groundwater drinking water standards for any other site-related groundwater contaminants found above drinking water standards during RD/RA at all points throughout the aquifer within a reasonable time frame for the site.

- Reduce TCE, PCE and any other site-related groundwater contaminants found in groundwater to concentrations corresponding to a cumulative excess lifetime cancer risk of 1×10^{-4} and a cumulative non-cancer hazard index less than 1 within a reasonable time frame for the site.

- Minimize the spread of groundwater contaminants.

- Ensure that hazardous levels of site-related vapors are not migrating into area homes.

- Ensure that contaminated groundwater is not impacting surface water and sediment as the groundwater discharges into the Rock River.

The federal and state drinking water standard for TCE and PCE is 5 µg/L. Hazardous levels of site-related vapors are those that would cause a potential cumulative excess lifetime cancer risk greater than 1×10^{-4} and a cumulative non-cancer hazard index greater than 1. Based on the results of the 2002 soil gas sampling and the 2000 and 2002 groundwater sampling, additional site-related groundwater contaminants may include benzene, ethylbenzene, toluene, xylenes, acetone, methylene chloride, Freon 113, 2-butanone (methyl ethyl ketone), 1,1,1-TCA, cis-1,2-DCE, and other breakdown products of PCE and TCE.

2.2 GENERAL RESPONSE ACTIONS

General response actions are actions that, if implemented singly or in combination, will satisfy the RAOs.

2.2.1 Groundwater

The general response actions for the groundwater contamination at the Evergreen Manor Site are as follows:

- No Action - Provides a baseline for comparison with other alternatives and is required by the NCP for the FS process.
- Institutional Controls - Prevents human exposure to the identified COCs but does not address reducing the toxicity, mobility, or volume of contamination.
- Containment - Limits or controls the migration of contaminants beyond the present area of contamination into adjacent areas, but does not contribute to reducing the toxicity or volume of contamination.
- Collection - Removes contaminated media to facilitate treatment or disposal actions but does not contribute to reducing the toxicity, mobility, or the volume of contamination.
- Treatment - Uses processes, implemented in-situ, on-site, or off-site, to reduce the toxicity, mobility, or volume of contaminants in the affected media.
- Disposal (in association with the collection or treatment actions) - Determines the ultimate location of treated or untreated media in an environmentally sound, publicly acceptable, and cost-effective manner.

2.2.1.1 No Action

No action means that no remedial action will be undertaken at the site. The site will continue in its current state, and no actions will be conducted to remove, isolate, or remediate the contamination. Under the no action response, long-term monitoring would not be used to assess changes in contaminant concentrations within effected media. No additional access or deed restrictions would be put into place. The NCP requires that the No Action alternative be included among the general response actions evaluated in every FS (40 CFR 300 430[e][b]) to provide a baseline for comparison against other remedial alternatives.

2.2.1.2 Institutional Controls

Institutional controls are non-engineering measures, usually legal or physical means, of limiting potential exposures to a site or medium of concern. Institutional controls prevent human exposure to the identified COCs but do not address reducing the toxicity, mobility, or volume of contamination. Examples of institutional controls cited in the NCP include land access, resource-use, and deed restrictions. Institutional controls can also include access restrictions such as fencing and site monitoring.

2.2.1.3 Containment

Containment refers to technologies that isolate contaminants from human and ecological contact, minimize migration of groundwater, and minimize vapor releases to the atmosphere. Containment limits or controls the migration of contaminants beyond the present area of contamination into adjacent areas, but does not contribute to reducing the toxicity or volume of contamination.

2.2.1.4 Collection

Collection activities remove contaminants to facilitate treatment or disposal actions. Extraction of contaminated groundwater is an example of a collection activity. The contaminated media can be treated or disposed of following excavation.

2.2.1.5 Treatment

Treatment processes are used to reduce the toxicity, mobility, or volume of contamination either in-situ or ex-situ. Compounds are either removed or the chemistry of the contaminant molecule is altered by physical/chemical, thermal, and/or biological processes.

2.2.1.6 Disposal

Treated or untreated wastes can be disposed of either on- or off-site. Determines the ultimate location of treated or untreated media in an environmentally sound, publicly acceptable, and cost-effective manner.

2.2.2 Air (Vapor Intrusion Pathway)

Both the GDER, Revision 1 (WESTON, 2003) and the Air Sampling Report, Revision 3 (WESTON, 2003) concluded that in order to fully evaluate the vapor intrusion pathway, soil gas, indoor air, soil, and shallow groundwater in the vadose zone need to be monitored on a periodic basis. This periodic monitoring, collectively termed as vapor intrusion monitoring, would be conducted at select residences and would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health. In addition, monitoring of the vapor intrusion pathway would facilitate differentiation of "background" (ambient air plus indoor air) sources of PCE, TCE, benzene, ethylbenzene, toluene, xylenes, acetone, methylene chloride, Freon 113, 2-butanone (methyl ethyl ketone), 1,1,1-TCA, cis-1,2-DCE and other breakdown products of PCE and TCE in indoor air and soil gas samples from site-related contamination. Thus, the general response action for the air medium is institutional control.

2.3 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

In this subsection, technologies and process options applicable to each general response action associated with the groundwater medium are identified and screened to eliminate those that cannot be implemented technically at the site. For the air medium, the remedial technology type and the technology process options associated with the applicable response action (institutional controls) are monitoring and short-term air monitoring, respectively. The term "technologies" refers to general categories of technologies, such as chemical/physical treatment, in-situ bioremediation, vertical barriers, etc. The term "process options" refers to specific processes within each technology type. For example, physical treatment would include such process options as air sparging, air stripping, and vapor extraction. The technology types and process options were identified based on a variety of reference sources including:

- *Remediation Technologies Screening Matrix and Reference Guide, Second Edition*, (DOD, 1994).
- *U.S. EPA Vendor Information System for Innovative Treatment Technologies* (VISITT).
- Federal Remediation Technologies Roundtable.

- Superfund Innovative Technology Evaluation (SITE) Program.
- National Technical Information Service (NTIS) Bibliographic Database.
- Literature search on various technical journals and conference proceedings.

The technology types and process options associated with each general response action for the shallow groundwater are summarized in Table 2-3. These technology types and process options represent the range of remedial technologies potentially applicable to address the contaminated groundwater. General descriptions of the process options are presented in Appendix B.

The remedial technologies were preliminarily screened for technical implementability based on the site and waste characteristics. The results of this screening are summarized in Table 2-4. The site and waste characteristics used for screening technologies include the following:

<u>Site Characteristics</u>

- The investigative area associated with the Evergreen Manor Site encompasses an area approximately two miles long by one-half mile wide. The site is situated in an area used primarily for residential, commercial, and industrial purposes; however, land along the north, east, and west border is used for recreational and agricultural purposes.
- Two prominent surface water features are present at the site, the Rock River and Dry Creek. The Rock River carries an average flow of approximately 4,200 cfs. The Dry Creek is a tributary to the Rock River. Based on the groundwater and surface water elevations measured along the contaminant plume groundwater is believed to discharge to the Rock River, but Dry Creek is perched above the groundwater table.

- The shallow aquifer consists of outwash deposits of sand and gravel, with localized zones containing greater amounts of silt. PCE and TCE contamination in the aquifer is assumed to extend to depths of up to 100 ft bgs.

- Based on the hydraulic gradient of 0.0015 ft/ft and the hydraulic conductivity of 0.22 cm/s (as calculated using the U.S. EPA Well Head Protection Area (WHPA) model in the RI), the average linear velocity within the shallow aquifer was calculated to be 0.54 ft/day.

- The groundwater contaminant plume, based on 2000 and 2002 investigations, is approximately 9,600 ft long (from north of Rockton Road to the Rock River), and ranges from approximately 700 to 3,600 ft wide. The plan area of the plume is approximately 555 acres (24.2 million ft^2).

<u>**Areas and Volumes of Media**</u>

- COCs in the groundwater include PCE and TCE. Assuming a soil porosity of 30 percent and an aquifer thickness of 70 ft, approximately 3.8 billion gallons of groundwater was estimated as being contaminated with chlorinated VOCs.

- VOCs were detected in air samples within the extent of groundwater contamination.

Based on technical implementability, groundwater process options and technology types retained for further analysis are listed in Table 2-6. As mentioned earlier, vapor intrusion monitoring, consisting of monitoring soil gas, indoor air, soil, and shallow groundwater in the vadose zone, is the only process option for the air medium at the Evergreen Manor Site.

2.4 EVALUATION OF PROCESS OPTIONS

2.4.1 Groundwater

In this stage of the screening, the processes considered to be implementable were evaluated in greater detail such that one representative process option, if possible, could be selected for each technology type. This process simplifies the subsequent development and evaluation of alternatives. The representative process option provides a basis for developing performance specifications during preliminary design; however, the specific process actually used to implement the remedial action at the site may not be selected until the remedial design phase. In some cases, more than one process options were selected for a technology type if two or more processes were sufficiently different in their performance that one would not adequately represent the other.

The process options were evaluated based on three criteria: effectiveness, implementability, and cost. These criteria are applied to evaluate and select process options which will satisfy the general response actions. At this stage, the evaluation focused more on effectiveness than on implementability and cost evaluation.

<u>Effectiveness Criterion</u>

The effectiveness criterion is an evaluation of the following:

- The potential effectiveness of the process options for handling the estimated areas or volumes of contaminated media as well as for meeting the remediation goals identified in the RAOs;
- The potential impact to human health and the environment during the construction and implementation phase; and
- The degree to which the process options are proven and reliable with respect to the site and waste characteristics.

Implementability Criterion

The implementability criterion is an evaluation of both the technical and administrative feasibility of implementing each of the technology options. Because the technical implementability has been previously considered during the preliminary screening of technology types, this more detailed evaluation places greater emphasis on the institutional aspects of implementability such as the ability to obtain required permits for off-site actions, availability of treatment, storage and disposal services (including capacity), and the availability of equipment and skilled workers necessary to implement the process option.

Cost Criterion

The cost criterion is an evaluation of the costs of the various process options within a given technology type; however, costs play a limited role at this point in the screening process. The cost evaluation was made based on best engineering judgment, and each process option was evaluated as to whether costs were high, medium, or low relative to other process options within the same technology type. The screening of the process options associated with each technology type for groundwater is presented in Table 2-5.

2.4.2 Air (Vapor Intrusion Pathway)

As mentioned earlier, vapor intrusion monitoring, consisting of monitoring soil gas, indoor air, soil, and shallow groundwater in the vadose zone, is the only process option for the air medium at the Evergreen Manor Site.

2.5 PROCESS OPTIONS RETAINED FOR FURTHER ANALYSIS

The groundwater process options and technology types that were retained for incorporation into the remedial action alternatives are presented in Table 2-6. The remedial action alternatives are presented in Section 3.

SECTION 3

DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section presents the development and screening of remedial action alternatives for groundwater present in the shallow aquifer at the Evergreen Manor site. The preliminary screening evaluates the developed alternatives as to their effectiveness, implementability, and cost and presents conditions under which the alternatives would be applicable and retained for detailed analysis.

3.1 DEVELOPMENT OF ALTERNATIVES

In accordance with the U.S. EPA RI/FS guidance document (U.S. EPA, 1988), the general response actions and process options that were retained for the groundwater and air media in Section 2 are combined to form alternatives for the entire site as a whole. The objective was to develop alternatives that would achieve the RAOs identified in Section 2.

The list of developed alternatives for groundwater and air is as follows:

- Alternative 1: – No Action.
- Alternative 2: – Institutional controls for air (vapor intrusion) and groundwater, extraction and treatment of contaminated groundwater, and off-site disposal of treated water.
- Alternative 3: – Institutional controls for air (vapor intrusion) and groundwater and monitored natural attenuation (MNA) of contaminated groundwater.
- Alternative 4: – Institutional controls for air (vapor intrusion) and groundwater and in-situ treatment of contaminated groundwater using iron-based permeable reactive barrier (PRB).

The range of technologies incorporated into the remedial alternatives for the entire site includes no action, institutional controls, collection, treatment, and disposal. A discussion of these alternatives, based on the site and waste characteristics and the retained process options for the various technology types, is presented below.

3.2 DESCRIPTION OF ALTERNATIVES

3.2.1 Alternative 1 - No Action

The No Action alternative is required by CERCLA to be carried forward to the detailed analysis phase in order to provide a baseline comparison with the other alternatives. The no action alternative implies that no remedial action would be undertaken at the site; therefore, the potential human health associated with exposure to COCs would not be mitigated.

3.2.2 Alternative 2: Institutional Controls for Air (Vapor Intrusion) and Groundwater, Extraction and Treatment of Contaminated Groundwater and Off-site Disposal of Treated Water

Alternative 2 consists of institutional controls including monitoring of vapor intrusion pathway, groundwater monitoring, groundwater use restrictions, and limited site access restrictions; extraction and ex-situ treatment of contaminated groundwater; post-treatment of treated groundwater, and discharge of treated water to the Rock River. Based on the relatively low concentrations of VOCs in the groundwater, treatment of air stripper emissions is not anticipated at this time.

A network of groundwater wells would be used to determine whether the groundwater extraction system is working as intended and to determine any change in the previously identified plume, any change in the vertical profile of the contaminant concentrations, and to determine any overall change in contaminant concentration. Existing and new monitoring wells as well as existing residential wells would provide an adequate groundwater monitoring network. An alternate water supply is already in place at the site. Institutional restrictions in the form of the Winnebago County Ordinance, which limits or restricts new wells from being installed in contaminated areas until the cleanup is complete, are already in place.

In order to fully evaluate the vapor intrusion pathway, soil gas, indoor air, soil, and shallow groundwater in the vadose zone would be monitored on a periodic basis. This periodic monitoring would be conducted at select residences and would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health. In addition, indoor air and soil gas sampling of select residences would facilitate differentiating "background" (ambient air plus indoor air) sources of PCE, TCE, benzene, ethylbenzene, toluene, xylenes, acetone, methylene chloride, Freon 113, 2-butanone (methyl ethyl ketone), 1,1,1-TCA, cis-1,2-DCE and other breakdown products of PCE and TCE in indoor air and soil gas samples from site-related contamination.

An extraction well network would be used to contain and capture the contaminated groundwater plume. Each well would be equipped with a dedicated pump. The extraction well spacings and pumping rates would be based on the required capture zone, fate and transport modeling, and the required time for cleanup. The extracted water from each well would be pumped to aboveground treatment systems. Each treatment system would consist of air stripping (i.e., packed tower aerator, shallow tray air stripper, or cascade aerator). Some sort of pretreatment or post-treatment (e.g., precipitation, filtration, etc.) of groundwater may be required. The off-gas treatment would be in accordance with the local and state air discharge regulations. Although treatment of the stripper emissions is not anticipated, this waste stream could be easily treated using vapor-phase activated carbon filters. The treated water would be discharged to the Rock River. The discharge would be monitored to ensure that it is in accordance with the substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit issued under the Clean Water Act and the Illinois Effluent Standards. An appropriate contingency plan would be in place to address any changes in land and groundwater use and/or changes in groundwater or soil vapor conditions.

3.2.3 Alternative 3: Institutional Controls for Air (Vapor Intrusion) and Groundwater and Monitored Natural Attenuation (MNA) of Contaminated Groundwater

Alternative 3 consists of institutional controls including monitoring of the vapor intrusion pathway, groundwater monitoring and restrictions on groundwater use, and monitoring and evaluation of groundwater contaminant degradation rates and pathways.

This alternative utilizes institutional controls and monitored natural attenuation to achieve the RAOs. An alternate water supply is already in place at the site. Institutional controls in the form of the Winnebago County Ordinance, which limits or restricts new wells from being installed in contaminated areas until the cleanup is complete, are already in place. This alternative would monitor the movement and concentration of contaminants by periodic groundwater sampling.

In order to fully evaluate the vapor intrusion pathway, soil gas, indoor air, soil, and shallow groundwater in the vadose zone would be monitored on a periodic basis. This periodic monitoring would be conducted at select residences and would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health. In addition, indoor air and soil gas sampling of select residences would facilitate differentiating "background" (ambient air plus indoor air) sources of PCE, TCE, benzene, ethylbenzene, toluene, xylenes, acetone, methylene chloride, Freon 113, 2-butanone (methyl ethyl ketone), 1,1,1-TCA, cis-1,2-DCE and other breakdown products of PCE and TCE in indoor air and soil gas samples from site-related contamination.

TCE/PCE groundwater cleanup levels would be achieved by MNA. Natural attenuation relies on natural subsurface processes such as dispersion, advection, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. An appropriate contingency plan would be in place to address any changes in land and groundwater use and/or changes in groundwater or soil vapor conditions.

3.2.4 Alternative 4: Institutional Controls for Air (Vapor Intrusion) and Groundwater and In-situ Treatment of Contaminated Groundwater Using Iron-based Permeable Reactive Barrier (PRB)

Major components of Alternative 4 consists of institutional controls including monitoring of the vapor intrusion pathway, groundwater monitoring and groundwater use restrictions, and treatment of the contaminated groundwater with a zero-valent iron permeable reactive barrier (PRB). The institutional control components of this alternative are similar to those described for Alternatives 2 and 3.

The groundwater would be treated in-situ using a PRB in a continuous configuration. The PRB would be installed across the flow path of the contaminant plume and across the vertical extent of the plume. The PRB would be constructed to allow groundwater to move passively through the wall while treating COCs by employing zero-valent iron (Fe[0]) to degrade the contaminants.

Reductive dechlorination using iron is a proven and effective treatment for chlorinated hydrocarbons. The reductive dechlorination of the chlorinated hydrocarbons present within the groundwater at the site would occur due to electron transfers (oxidation-reduction reactions). The degradation process of the chlorinated solvents involves corrosion (oxidation) of the Fe(0) by the chlorinated hydrocarbon. As the iron is oxidized, a chlorine atom is removed from the chlorinated hydrocarbon by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron. The net reaction results in hydrocarbon products, iron(II) (Fe^{2+}), and chlorine ions (Cl^-). This reaction would result in the chlorine ions being replaced by hydrogen species, ultimately yielding nontoxic ethene or ethane, which can be easily degraded via natural biodegradation. An appropriate contingency plan would be in place to address any changes in land and groundwater use and/or changes in groundwater or soil vapor conditions.

3.3 PRELIMINARY SCREENING OF ALTERNATIVES

This section presents an initial screening of the groundwater remedial alternatives developed to address contamination in the various media at the site. During the initial screening of groundwater technologies and process options (Section 2), the evaluation was conducted primarily on the basis of whether or not the technologies and process options could meet the particular remedial response objective. During alternative screening, the entire groundwater alternative was evaluated with respect to its effectiveness, implementability, and cost.

Effectiveness Criterion

This criterion was used to evaluate the effectiveness of the alternatives for protecting human health and the environment. Each alternative was also evaluated based on its effectiveness for reducing the toxicity, mobility, or volume of the COCs. Both short- and long-term components of effectiveness were evaluated: short-term effectiveness refers to the construction and implementation period; long-term effectiveness refers to the period after the remedial action is complete. Reduction of toxicity, mobility, or volume refers to changes in one or more characteristics of the contaminated media through the use of treatment that decreases the inherent threats or risks associated with the contaminated material.

Implementability Criterion

The implementability criterion was used to evaluate each alternative with respect to its technical and administrative feasibility and the availability of necessary technologies and services. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services and capacity; and the requirements for and availability of specific equipment and technical specialists.

Cost Criterion

The cost criterion is a general cost analysis that was used to identify alternatives that are significantly more costly than other alternatives achieving the same level of effectiveness. Absolute accuracy of cost estimates during this stage of screening is not essential. For preliminary screening purposes, the costs are classified as low, moderate, moderately high or high.

The cost estimates for the various alternatives during this stage were based on one or more of the following: cost curves, generic unit costs, vendor information, conventional cost-estimating guides, and prior similar estimates as modified by site-specific information. Preliminary screening of the alternatives is discussed in the following subsections. Table 3-1 presents the summary of the preliminary screening of alternatives.

3.3.1 Alternative 1: No Action

Alternative 1 consists of no action. The no action alternative is retained because it provides a baseline for comparison with other alternatives, as required by the NCP for the FS process. This alternative would not be effective in protecting human health and the environment or reducing the toxicity, mobility, or volume of the COCs within the various environmental media at the site. The no action alternative will not meet the human health or environmental protection RAOs. Since this alternative does not involve implementing any process options, this alternative is easily implementable and has no associated cost.

Alternative 1 is evaluated based on effectiveness, implementability, and cost in the following subsections.

3.3.1.1 Effectiveness

Since Alternative 1 consists of no remedial activities, there is no reduction of present and future risks associated with the alternative; and therefore, no protection of human health and the environment is afforded. This remedy is effective in the short-term as the site does not pose an imminent threat to human health or the environment. Current site risks are manageable without action if additional time is required to select or evaluate alternatives; however, this alternative does not offer long-term effectiveness and permanence because no remedial action is implemented.

3.3.1.2 Implementability

Alternative 1 would be easily implemented because there are no associated activities to perform.

3.3.1.3 Cost

There is no cost associated with Alternative 1 since no remedial activities would be implemented.

3.3.2 Alternative 2: Institutional Controls for Air (Vapor Intrusion) and Groundwater, Extraction and Treatment of Contaminated Groundwater, and Off-site Disposal of Treated Water

This alternative consists of the following components for addressing the groundwater media:

- Institutional controls consisting of vapor intrusion pathway monitoring, groundwater use restrictions, limited access restrictions, and groundwater monitoring.
- Immobilization of impacted groundwater plume and extraction of impacted water by conventional pumping methods.
- Treatment of impacted groundwater using an air stripping technology.
- Pre- and post-treatment of groundwater, if necessary.
- Discharge of treated groundwater to the Rock River.

An evaluation of Alternative 2, based on effectiveness, implementability, and cost, is presented in the following subsections.

3.3.2.1 Effectiveness

Institutional controls in the form of groundwater monitoring, alternate drinking supply and groundwater use restrictions which are already in place would be protective of human health until RAOs are achieved. Appropriate site access restrictions (i.e., existing fencing and gates) would be maintained to prevent unauthorized visitors from entering the treatment area. Monitoring of the vapor intrusion pathway would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health. Institutional controls are effective in limiting exposure; however, the effectiveness of these controls are based on enforcement.

The pump-and-treat system with air stripping is an established remedial approach for remediation of VOCs in groundwater. The site geologic and hydrogeologic conditions are suited for groundwater extraction. Groundwater extraction would also be effective in capturing groundwater from varying depths within the aquifer. The extracted groundwater would be effectively treated using air stripping to remove VOCs from the groundwater. Off-gas treatment, if required, can effectively meet the local and state air discharge regulations. If necessary, conventional filtration techniques can be implemented to polish groundwater to meet discharge standards.

The residual risk of groundwater contamination would be decreased over time through extraction and treatment. The effectiveness and time to achieve groundwater RAOs would be easy to monitor using existing and new monitoring wells as well as existing residential wells. Implementation of this alternative would result in temporary increase in noise, truck traffic, and dust generation during construction of treatment building, piping, and installation of extraction wells. Noise from construction activities would be controlled by conducting these activities during daytime hours and giving due consideration to concerns of the residents. The community would not be exposed to the hazards of the groundwater during off-site disposal. Workers would follow appropriate health and safety measures to prevent exposure to COCs during construction activities. Implementation of appropriate health and safety measures will ensure worker protection. There is a potential for workers to be exposed to airborne VOCs volatilized from groundwater during the start-up and operation of the groundwater remediation system due to fugitive emissions. Health and safety air monitoring would be conducted during start-up of the treatment system and during routine maintenance checks of the equipment to mitigate this risk. Groundwater monitoring would be required for several years after RAOs are met to ensure that levels do not rebound due to contribution from a continuing or secondary source. The extraction of the contaminated groundwater would prevent both its discharge into Rock River and further migration. Groundwater monitoring would be required after RAOs are achieved to ensure that contaminant levels do not rebound due to contribution from a continuing or secondary source. Upon attainment of the RAOs, the remedy would be permanent unless a continuing or secondary source exists.

Based on the protectiveness of human health and the environment, the overall effectiveness of this alternative in meeting the RAOs would be high.

3.3.2.2 Implementability

Institutional controls including groundwater monitoring and groundwater restrictions and the vapor intrusion monitoring program would be easy to implement. Based on known site geology, the installation of extraction wells would be easy to implement. The pump-and-treat system would be easy to construct since equipment, materials, trained personnel, contractors, and suppliers are readily available; however, operation and maintenance of the equipment will be required. The major implementability issue with the pump and treat system would be associated with the operation and maintenance of the system. Typical operation problems for the pump-and-treat system stem from the failure of surface equipment, electrical and mechanical control systems, biofouling or chemical precipitation causing plugging of wells, pumps, surface plumbing, and the air stripper. Regular maintenance would mitigate operating problems; however, maintenance would entail a significant amount of effort. Land acquisition for the treatment buildings and associated piping may entail some difficultly. Discharge of stripper emissions and treated water would require permits, which would be relatively easy to arrange.

If additional remedial actions are needed to treat the environmental media at the site, future remedial actions could be easily implemented. The discharge permit would be relatively easyto obtain and would set the effluent requirements for the treatment system. Verification samples of the treated groundwater would ensure that permit requirements are met.

Cost

The cost of this alternative would be high. A detailed cost analysis will be performed later in the FS process.

3.3.3 Alternative 3: Institutional Controls for Air (Vapor Intrusion) and Groundwater and Monitored Natural Attenuation (MNA) of Contaminated Groundwater

Major components of Alternative 3 are as follows:

- Institutional controls consisting of vapor intrusion pathway monitoring, groundwater monitoring and groundwater use restrictions.
- Evaluation of contaminant degradation rates and pathways.

An evaluation of Alternative 3, based on effectiveness, implementability, and cost, is presented in the following subsections.

3.3.3.1 Effectiveness

Institutional controls in the form of alternate drinking supply and groundwater use restrictions which are already in place would be protective of human health until RAOs are achieved. Monitoring of the vapor intrusion pathway would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health Institutional controls are effective in limiting exposure; however, the effectiveness of these controls are based on enforcement. MNA is effective only as a long-term response action.

The overall decrease of the contaminated plume, favorable site conditions, contaminants amenable to natural attenuation substantiated by overall decrease in concentrations, presence of PCE upgradient possibly breaking down to TCE (detected at higher concentration downgradient), and presence of numerous daughter products at low levels throughout the plume and other site-specific data presented in this report, appears to indicate that monitored natural attenuation (MNA) may be an effective alternative at the Evergreen Manor site.

The residual risk of groundwater contamination would be decreased over time through natural attenuation. The effectiveness and time to achieve groundwater RAOs would be easy to monitor using existing and new monitoring wells as well as existing residential wells. However, the monitoring program would be more extensive than Alternatives 2 and 4. Implementation of this alternative would result in minimal increase in noise, truck traffic, and dust generation during installation of monitoring wells and drilling activities associated with periodic monitoring of soil gas samples, shallow groundwater samples, and soil samples. Noise from construction activities would be controlled by conducting these activities during daytime hours and giving due consideration to concerns of the residents. The community would not be exposed to the hazards of the groundwater during off-site disposal. Workers would follow appropriate health and safety measures to prevent exposure to COCs during well installation and monitoring activities. Implementation of appropriate health and safety measures would ensure worker protection.

Extensive groundwater monitoring would be required for several years after RAOs are met to ensure that levels do not rebound due to contribution from a continuing or secondary source. Upon attainment of the RAOs, the remedy would be permanent unless a continuing or secondary source exists.

Based on the protectiveness of human health and the environment afforded by this alternative, the overall effectiveness of this alternative in achieving the RAOs would be high.

3.3.3.2 Implementability

Long-term groundwater monitoring is easily implementable. Institutional controls including groundwater monitoring and groundwater restrictions and the vapor intrusion monitoring program would be easy to implement. Based on known site geology, the installation of monitoring wells would be easy to implement.

If additional remedial actions are needed to treat the environmental media at the site, future remedial actions could be easily implemented. Detailed contaminant fate and transport modeling would be needed to monitor the effectiveness of natural attenuation. The U.S. EPA approves monitored natural attenuation as a final remedy only after detailed evaluation of the site-specific data is conducted. Based on data evaluation conducted to date, it appears that this alternative would be relatively easy to implement.

3.3.3.3 Cost

The cost associated with this alternative would be moderate.

3.3.4 Alternative 4: Institutional Controls for Air (Vapor Intrusion) and Groundwater and In-situ Treatment of Contaminated Groundwater using Iron-based Permeable Reactive Barrier (PRB)

Major components of Alternative 4 consist of the following:

- Institutional controls including vapor intrusion and groundwater monitoring and groundwater use restrictions.

- In-situ treatment of contaminated groundwater using continuous zero-valent iron permeable reactive barrier (PRB).

An evaluation of Alternative 4, based on effectiveness, implementability, and cost, is presented in the following subsections.

3.3.4.1 Effectiveness

Institutional controls in the form of alternate drinking supply and groundwater use restrictions, which are already in place, would be protective of human health until RAOs are achieved. Appropriate site access restrictions (i.e., existing fencing and gates) would be maintained to prevent unauthorized visitors from entering the treatment area. Monitoring of the vapor intrusion pathway would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health. Institutional controls are effective in limiting exposure; however, the effectiveness of these controls are based on enforcement.

Reductive dechlorination using iron is a proven and effective treatment for chlorinated hydrocarbons. The effectiveness of the PRB is dependent on the geochemical parameters (i.e., oxidation-reduction potential [ORP], dissolved oxygen [DO], nitrate, ferrous iron, sulfate, methane, and total organic carbon [TOC]) of the aquifer. A pilot study would be required to determine the effectiveness of the PRB with respect to geochemical parameters and subsurface conditions at the site.

A high content of DO within the water can cause additional reactions to occur within the subsurface. For example, under aerobic conditions DO is usually the preferred electron acceptor for iron oxidation and can compete with the chlorinated hydrocarbon. Consequently, anaerobic or semi-aerobic environments are more amenable to iron treatment. Chlorinated hydrocarbons have oxidizing potentials very similar to that of oxygen. The rapid consumption of DO at the entrance to an iron system has been shown to result in these precipitates that might impact a system's hydraulic performance at its upgradient interface. Formation of such precipitates would lower of the hydraulic conductivity of the PRB's. This lowered hydraulic conductivity could cause contaminants to migrate laterally and vertically around the PRB and thus, could impact the effectiveness of the treatment system.

The reaction mechanisms associated with the iron-based gate are surface-area dependent. The primary determinant of degradation rate is the specific surface area, or the surface area of iron per unit volume of pore water. Degradation rates are specific to the hydrocarbon. Adverse chemical reactions or byproducts may occur when reacting with constituents in the contaminant plume. Incomplete dechlorination of a higher-chlorinated ethene (e.g., PCE, TCE, etc.) could produce an intermediate product, such as vinyl chloride, which is more hazardous and more persistent than the parent compounds.

The residual risk of groundwater contamination would be decreased over time through treatment. The effectiveness and time to achieve groundwater RAOs would be easy to monitor using existing and new monitoring wells as well as existing residential wells. Implementation of this alternative would result in a significant increase in noise, truck traffic, and dust generation during installation of the PRB barrier. Noise from construction activities would be controlled by conducting these activities during daytime hours and giving due consideration to concerns of the residents. Workers would follow appropriate health and safety measures to prevent exposure to COCs during well installation and monitoring activities. Implementation of appropriate health and safety measures would ensure worker protection.

Extensive groundwater monitoring would be required for several years after RAOs are met to ensure that levels do not rebound due to contribution from a continuing or secondary source. Upon attainment of the RAOs, the remedy would be permanent unless a continuing or secondary source exists.

Based on the protectiveness of the human health and environment and serious complications that may result if fouling of the PRB occurs, the overall effectiveness of this alternative in achieving the RAOs would be moderate.

3.3.4.2 Implementability

Institutional controls including groundwater monitoring and groundwater restrictions and the air monitoring program would be easy to implement.

The PRB would be constructed using trenching techniques to a depth of approximately 100 ft bgs. Due to the significant depth of contamination, conventional excavation techniques may be difficult to implement. The excavated soil can be mixed with the reactive material or disposed of off-site.

The PRB would be a relatively permanent structure. Extensive groundwater modeling would be required to design the PRB and the appropriate location. Once installed, the PRB components would be difficult to relocate and change. Additional remedial actions, if needed, would have to be installed at other locations within the groundwater plume.

The PRB must be designed based on the hydrogeology of the site, the contaminant distribution in the groundwater, the geochemical composition of the groundwater, and the geotechnical and topographic features of the site. Seasonal variations in factors such as groundwater flow and rainfall events could affect some of these site features. Additionally, discontinuities may occur in the reactive barrier causing part of the flow to pass untreated through the reactive barrier. The PRB should operate for years with minimal, if any, maintenance; however, periodic replacement or rejuvenation of the reaction medium might be required after its capacity is exhausted or it is clogged by precipitants and/or microorganisms.

When sufficient oxygen is present, the Fe^{2+} generated further oxidizes to iron(III) (Fe^{3+}) and can form precipitates at the elevated pH typical of corroding Fe systems. A high concentration of DO can quickly corrode the first few inches of iron in the reactive zone and cause an increase in pH. As pH increases, iron precipitates are generated that can exert additional chemical and physical effects within the reactive systems. As a result, these reactions may impact iron reactivity and cause a decline in permeability within the iron treatment zone. Therefore, the aerobic nature of the groundwater can be potentially detrimental to this technology. This can be mitigated by injecting a carbon source (i.e., molasses) upgradient of the gate or by constructing a pretreatment zone containing a coarse medium (sand or pea gravel) mixed with a small percentage of iron to remove DO from the groundwater before it enters the reactive zone. The use of a carbon source (i.e., molasses) to remove DO from the groundwater would need to be performed over the life of the remedial action which would have an adverse effect on implementability of this alternative. Additionally, the presence of iron- and sulfate-reducing bacteria and methanogens within the groundwater could influence Fe(0) reductive dehalogenation reactions through favorable impacts on redox potential. Although beneficial to the reductive dechlorination process, this activity may cause biofouling of the permeable treatment zone. Moderate chlorine concentrations associated with reductive dechlorination may help to reduce bacterial growth. Again, this would have a significant impact on the implementability of this alternative.

The discharge permit, if needed, would be relatively easy to obtain and would set the effluent requirements for the treatment system. Verification samples of the treated groundwater would ensure that permit requirements are met.

Due to the space limitation along the northern bank of the Rock River, land acquisition or easements would be difficult to obtain, and movement of materials and equipment would also be onerous.

3.3.4.3 Cost

The cost category of this alternative is high. There would be relatively high mobilization and installation costs associated with transporting and setting up the large equipment necessary for installation of the PRB. Studies indicate that the reactive medium is used up very slowly; therefore, PRBs have the potential to passively treat the plume over numerous years, resulting in low annual operating costs other than site monitoring. Since the iron is depleted very slowly, it is unlikely that the iron would require replenishment; however, this would present a major cost factor for this alternative, if necessary.

3.4 PRELIMINARY SCREENING RESULTS

Alternative 1 consists of no action and is not effective in protecting human health and the environment. This alternative is readily implementable and has no associated cost. The no action alternative was retained for detailed analysis because it provides a baseline for comparison with alternatives as required by the NCP for the FS process.

Alternative 2 is highly effective, relatively easy to implement, has a high cost, and would require close supervision and maintenance. RAOs for the groundwater would be met within a relatively short period of time; however, the effectiveness of this alternative and the time to meet the RAOs is contingent upon the absence of a continuing or secondary source and the known horizontal and vertical extent of contamination. This alternative was retained for further analysis.

Alternative 3 is moderately effective, is easy to implement, has a moderate cost, and would require long-term monitoring. The time required to meet the RAOs would be higher than Alternative 2. As in the case of Alternatives 2 and 4, the effectiveness of this alternative is contingent upon the absence of a continuing or secondary source and the known horizontal and vertical extent of contamination. This alternative was retained for further analysis.

Alternative 4 is moderately effective, is difficult to implement, and has a high cost. The time required to meet the RAOs would be similar to Alternative 2. Due to the uncertainty of the effectiveness of the PRB with respect to geological conditions and subsurface chemistry at the site and the difficulty in modeling and implementing, this alternative was not retained for further analysis.

SECTION 4

DETAILED AND COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents detailed and comparative analysis of the groundwater remedial alternatives that were developed and retained in Section 3 from the technologies and process options retained during the screening process performed in Section 2. The objective of the detailed analysis is to present sufficient information to adequately compare the alternatives such that an appropriate remedy for the site may be selected and to demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD. This analysis has been performed in accordance with the NCP, as presented in 40 CFR 300.430(e)(9), and follows the format of the U.S. EPA RI/FS guidance document (U.S. EPA, 1988).

4.1 OVERVIEW OF THE DETAILED ANALYSIS

In accordance with the U.S. EPA RI/FS guidance document, the alternatives must be evaluated to meet the following objectives:

- To further define each alternative's components with respect to quantities (e.g., areas, volumes, masses, etc.), the technologies that would be utilized, and any performance requirements associated with the technologies.
- To provide an assessment of each alternative's ability to meet the evaluation criterion (defined below).
- To provide a comparative analysis of the alternatives in order to assess the relative performance of each alternative with respect to the evaluation criteria.

In Section 3, the alternatives were preliminarily screened, based on the short- and long-term aspects of three broad criteria: effectiveness; implementability; and cost. Based on the results of the preliminary screening, the following alternatives were retained:

- Alternative 1: – No Action.

- Alternative 2: – Institutional controls for air (vapor intrusion) and groundwater, extraction and treatment of contaminated groundwater, and off-site disposal of treated water.

- Alternative 3: – Institutional controls for air (vapor intrusion) and groundwater and monitored natural attenuation (MNA) of contaminated groundwater.

During the detailed analysis of the alternatives presented in this section, the screening criteria are elaborated upon to develop a total of nine criteria. The nine evaluation criteria encompass statutory requirements and technical, cost, and institutional considerations. Assessments against two of the criteria relate directly to statutory findings that must ultimately be made in the ROD; therefore, these are categorized as "threshold" criteria since an alternative may not be implemented without meeting them. The threshold criteria are as follows:

- Overall Protection of Human Health and the Environment – The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

- Compliance with ARARs – This assessment describes how the alternative complies with ARARs unless a waiver is provided, in which case this criteria describes why the waiver is justified. The assessment also addresses regulations or guidance that U.S. EPA and IEPA have agreed are "to be considered" (TBC).

The five criteria listed below represent the primary criteria upon which the detailed analysis is based and are commonly referred to as the "balancing" criteria:

- Long-Term Effectiveness and Permanence – The assessment of alternatives against this criterion evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment after RAOs have been achieved.

- Reduction of Toxicity, Mobility, and Volume Through Treatment – The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ.

- Short-Term Effectiveness – This assessment examines the effectiveness of the alternatives in protecting human health and the environment during the construction and implementation of a remedy until RAOs have been met. This criterion also evaluates the time required to implement and achieve the RAOs.

- Implementability – This assessment evaluates the technical and administrative feasibility of the alternatives as well as the availability of required goods and services that are required to implement the remedy.

- Cost – This assessment evaluates the capital cost and operation and maintenance (O&M) costs of each alternative. In addition, the present worth of annualized costs associated with each alternative is calculated using an annualized discount rate of 7% before taxes and after inflation. Costs are compared on a present-worth basis in terms of year 2003 dollars. The level of detail employed in developing these estimates is appropriate for making choices between alternatives, but the estimates are not intended for use in budgetary planning.

The final two criteria will be evaluated following U.S. EPA receipt of comments on the FS Report and the proposed plan. These criteria are as follows:

- State Acceptance – The assessment against this criterion reflects comments from Federal and all Illinois agencies with an interest in the site.

- Community Acceptance – The assessment against this criterion reflects the community's apparent preferences and/or concerns regarding the alternatives.

4.1.1 Protectiveness of Human Health and the Environment

The assessment of remedial action alternatives under this criterion describes how the alternatives achieve and maintain protection of human health and the environment. This criterion requires an overall evaluation of how site risk levels posed through each exposure pathway are eliminated, reduced, or controlled.

4.1.2 Compliance with Potential ARARs

This criterion is used to determine the extent to which each alternative will meet all of its federal and state ARARs (presented in Appendix A). Appendix A presents requirements which the U.S. EPA and all interested Illinois and local agencies identified as potentially applicable, or relevant and appropriate.

4.1.3 Long-Term Effectiveness and Permanence

This criterion addresses the potential risks remaining at the site after remedial action has been implemented and the RAOs have been attained. The following factors are considered in the long-term effectiveness:

- Magnitude of the residual risks remaining at the completion of remedial activities; and
- Adequacy and long-term reliability of management and technical controls for providing continued protection from the residual risks.

4.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, and/or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. The following considerations are applied to each alternative:

- The treatment processes the remedy will employ and the materials they will treat;

- The amount of hazardous materials that will be destroyed or treated, including how the principal threat(s) will be addressed;
- The degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude);
- The degree to which the treatment will be reversible;
- The type and quantity of treatment residuals that will remain following treatment; and
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

4.1.5 Short-Term Effectiveness

This evaluation criterion addresses the effects of the alternatives during the construction and implementation phase and up until RAOs have been met. The following considerations can be applied to each alternative:

- Protection of the community from any risk that results from implementation of proposed remedial actions;
- Protection of workers from any threats that may be posed during remedial actions and the effectiveness and reliability of protective measures that would be taken;
- Environmental impacts that may result from the implementation of an alternative and a corresponding evaluation of available mitigation measures; and
- The time required to achieve RAOs.

4.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing the alternatives and the availability of the necessary services and materials. This criterion involves analysis of the alternatives for the following factors:

- Ability to construct the technology and the reliability of its operation;
- Ease of undertaking additional remediation, if necessary;
- Ability to adequately monitor migration and exposure pathways;
- Availability of services and materials; and
- Coordination between agencies.

4.1.7 Cost

Cost estimates for the alternatives were prepared primarily by contacting potential materials suppliers and other contractors and by using construction estimating resources. The costs were estimated from the information available at the time of the estimate. Whenever possible, more than one supplier was contacted to estimate the costs; therefore, the costs will be within the desired range of accuracy of +50 to -30 percent of the actual final cost. Final costs will depend on actual labor and material costs, actual site conditions, market conditions, final project scope, engineering between the feasibility study and final design, final project schedule, productivity, and other variable factors. As a result, the final costs will vary from the estimates presented in this report; however, most of these factors should not affect the relative cost differences between the alternatives.

Total capital costs consist of the direct and indirect costs required to initiate and implement a remedial action. Direct costs include costs for construction, labor, and materials. Indirect costs consist of engineering, permitting, supervising, and other similar services. Construction contingencies account for unknown costs. Unknown costs include a variety of factors that would tend to increase costs associated with a given project scope, such as bidding climate, adverse weather conditions, availability of materials, contractors' uncertainty regarding liability and insurance, regulatory or policy changes that may affect FS assumptions, and geotechnical unknowns. Contingencies do not include allowances for price inflation and unforeseeable, abnormal technical difficulties.

The present-worth cost represents the amount of money that, if invested in the current year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. In conducting the present-worth analysis, a discount rate of 7% and operating life of 30 years or less (depending upon the time required for an alternative to achieve the RAOs) was assumed. The 30-year period is based on the U.S. EPA RI/FS guidance document. For perpetuity, the present worth of the incremental cost after 30 years is very small.

4.1.8 State Acceptance

As stated in the U.S. EPA RI/FS guidance document, this criterion will be addressed in the ROD based on comments submitted to the U.S. EPA by state agencies during the public comment period.

4.1.9 Community Acceptance

The community is provided with an opportunity to review the FS Report during the 30-day public comment period. During and after the public comment period, U.S. EPA typically receives comments by mail. The public is also given the opportunity to express concerns and comments during a public meeting, which is usually held during the 30-day public comment period. Public concerns and comments are responded to in the Responsiveness Summary section of the ROD.

4.2 DETAILED ANALYSIS OF ALTERNATIVES

The alternatives that were retained in Section 3 are as follows:

- Alternative 1: – No Action.
- Alternative 2: – Institutional controls for air (vapor intrusion) and groundwater, extraction and treatment of contaminated groundwater, and off-site disposal of treated water.

- Alternative 3: – Institutional controls for air (vapor intrusion) and groundwater and monitored natural attenuation (MNA) of contaminated groundwater.

Detailed descriptions and analyses for each of these alternatives are presented in the following subsections.

4.2.1 Alternative 1 – No Action

4.2.1.1 Detailed Description of Alternative 1

The No Action alternative is required by CERCLA to be carried forward to the detailed analysis phase of the FS process in order to provide a baseline for comparison with other alternatives. The No Action alternative implies that no remedial action would be undertaken at the site.

4.2.1.2 Detailed Analysis of Alternative 1

Alternative 1 is assessed based on the nine criteria in the following paragraphs.

Overall Protection of Human Health and the Environment

Alternative 1 does not meet the requirement for overall protection of human health and the environment. U.S. EPA expects chemical concentrations in the groundwater to naturally decrease over time. Additionally, as the levels of contaminants in the groundwater decrease, the levels of site-related contaminants in the soil gas and in area homes are also expected to decrease. However, the no action alternative does not include the institutional controls, monitoring programs or contingency actions that would be needed to ensure that human health and the environment would be protected.

Compliance with ARARs

Table 4-1 lists potential ARARs for the remedial alternatives and whether implementation of the alternatives would meet the ARARs. Because the no-action alternative does not involve conducting any remedial action at the site, an ARARs analysis is not necessary for Alternative 1.

Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness and permanence. U.S. EPA expects chemical concentrations in the groundwater and the soil gas to attenuate naturally over time. However, because this alternative does not require any cleanup levels or include monitoring or contingency actions, the long-term effectiveness and permanence of this alternative could not be assured.

Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative 1 does not reduce the toxicity, mobility, or volume of the COCs through treatment because no remedial action is implemented. Under current conditions and the conditions observed at the site since 1990, Alternative 1 would provide for some reduction of toxicity, mobility or volume through natural treatment processes, since the presence of cis-1,2-DCE and other break-down products indicate that some of the contaminants are degrading. However, this degree of biodegradation is not significant. Also, under Alternative 1, the effects of these natural processes could not be verified since there would not be any monitoring.

Short-Term Effectiveness

Alternative 1 would not be effective in the short-term since this alternative does not include institutional controls to prevent people from using the contaminated groundwater until the groundwater quality improves; monitoring to track and evaluate the effectiveness of the natural cleanup processes and to ensure protectiveness over time, monitoring to ensure that the vapor intrusion pathway is not a threat; or contingency actions to be implemented if the natural cleanup processes are not performing as anticipated, or if site conditions change to the extent that these processes are no longer protective, or if the vapor intrusion pathway is found to be a threat.

Implementability

Alternative 1 would be easily implemented because there are no associated activities to perform.

Cost

There is no cost associated with Alternative 1 since no remedial activities would be implemented.

State Acceptance

Alternative 1 will be evaluated for this criterion following U.S. EPA receipt of formal comments regarding the FS Report and U.S. EPA's proposed plan from all Illinois state agencies that have an interest in the site.

Community Acceptance

Alternative 1 will be evaluated for this criterion following U.S. EPA receipt of formal comments regarding the FS Report and U.S. EPA's proposed plan from the community.

4.2.2 Alternative 2: Institutional Controls for Air (Vapor Intrusion) and Groundwater, Extraction and Treatment of Contaminated Groundwater, and Off-site Disposal of Treated Water

4.2.2.1 Detailed Description of Alternative 2

Alternative 2 consists of institutional controls including monitoring of the vapor intrusion pathway, groundwater monitoring, groundwater use restrictions, and limited site access restrictions; extraction and ex-situ treatment of contaminated groundwater; post-treatment of treated groundwater, and discharge of treated water to the Rock River. Based on the relatively low concentrations of VOCs in the groundwater, treatment of air stripper emissions is not anticipated at this time. A detailed discussion of the major components of this alternative is presented in the following text.

Site Access Restriction

A chain-link fence would be installed around the two treatment buildings in order to restrict access to the site and maintain security of the equipment. The fence would require maintenance until the RAOs are attained.

Groundwater Use Restrictions

The Hononegah Heights, Evergreen Manor, Tresemer and Old Farm subdivisions are part of Roscoe Township. Roscoe Township is located within the North Park Public Water District (NPPWD), however, not all residences within these subdivisions receive their water from the NPPWD. Prior to 1999, the residences within the subdivisions obtained their water from private residential wells. Based on limited well construction data available for review, these residential wells were completed within the shallow sand and gravel outwash deposits at average depths of 55 to 65 feet bgs, with depths ranging from 43 feet to 105 feet bgs. Due to the VOC-affected groundwater in the shallow aquifer related to the Evergreen Manor site and the Warner Electric RCRA site, many of the residences in the area are connected to the NPPWD water supply system, and private wells associated with these homes have been abandoned.

Between 1999 and 2000, the U.S. EPA connected a total of 262 residences located within the Evergreen Manor site to the NPPWD water supply. In addition, 19 of 21 homes included in a "buffer zone" were connected to the NPPWD water supply as a precaution. These residences are depicted on Figure 1-5. It should be noted, however, that due to the uncertainties associated with the exact addresses not all residences connected to the NPPWD are shown. At the request of the current landowners, two homes located within the southern perimeter of the "buffer zone" were not connected to the NPPWD water supply. As shown in Figure 1-5, these two residences are located outside of the eastern boundary of the contamination plume. In May 2001, five residences located adjacent to the contamination plume, including one which had previously declined to be connected to the NPPWD water supply, were sampled by the IDPH. The results of this sampling indicated that the groundwater in the vicinity of these residences has remained unaffected by the site contamination. Upon review of the NPPWD service records, it is apparent that additional residences and/or commercial properties within the vicinity of the Evergreen Manor Site may be using private wells for potable water. These locations are depicted on Figure 1-6.

Groundwater use at the site would be restricted during remediation until RAOs are met. An alternate water supply system is already in place. To reduce the likelihood of exposure to the contaminated groundwater beneath the Evergreen Manor site, Winnebago County has implemented an ordinance that requires all residences to be connected to a public water supply system if they are within 200-feet of a system. In addition, the county requires property owners to obtain well permits for new or existing well repairs. This permit provides the county the opportunity to notify the applicant about the location of a contamination plume and provide recommendations for additional water treatment, as well as require new wells to be drilled to depths believed to be beneath a contamination plume.

Groundwater Monitoring

In order to determine whether the groundwater extraction system is working as intended and to determine any change in the previously identified plume, any change in the vertical profile of the contaminant concentrations, and to determine any overall change in contaminant concentration, groundwater monitoring period would be conducted for a period of eight years, which is also the time required to achieve the RAOs. A detailed discussion on the time required to achieve the RAOs is presented later in this subsection. Under this alternative, a total of 16 monitoring wells including 10 existing and six new monitoring wells would be sampled and analyzed for VOCs until RAOs are achieved. All monitoring wells would be sampled on a quarterly basis for the first five years, semi-annually for the next two years, and annually for last year. The actual number of monitoring wells and frequency of sampling would be determined during the remedial design phase and would be based on results of additional site characterization and groundwater modeling conducted during the pre-design phase. Additional site characterization required prior to implementation of this alternatives is discussed later in this subsection.

In order to monitor the impact of groundwater plume on private wells, 10 private wells would be sampled and analyzed for VOCs until the RAOs are achieved. These private wells would be sampled on a quarterly basis for the first five years, semiannually for the next two years, and annually for the last year. The actual number of private wells and frequency of sampling would be determined during the remedial design phase and would be based on results of additional site characterization and groundwater modeling conducted during the pre-design phase. Additional site characterization required prior to implementation of this alternatives is discussed later in this subsection.

Monitoring of Vapor Intrusion Pathway

In order to monitor potential threats from the vapor intrusion pathway, soil gas samples, indoor air samples, soil samples, and shallow groundwater samples from the vadose zone would be collected and analyzed for VOCs. Monitoring of the vapor intrusion pathway would be conducted at select residences and would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health. Concurrent sampling and evaluation of indoor air, soil gas, soil, and shallow groundwater in the vadose would facilitate differentiation of "background" (ambient air plus indoor air) sources of PCE, TCE, benzene, ethylbenzene, toluene, xylenes, acetone, methylene chloride, Freon 113, 2-butanone (methyl ethyl ketone), 1,1,1-TCA, cis-1,2-DCE and other breakdown products of PCE and TCE in indoor air and soil gas samples from site-related contamination.

For the purposes of this FS, it is assumed that Approximately 25 homes would be targeted for monitoring and evaluating the vapor intrusion pathway. Actual number of homes would depend on the results of the initial soil gas and groundwater sampling conducted during the initial vapor intrusion site characterization efforts. Three 24-hour indoor air sample would be collected from each targeted home for a total of 75 indoor air samples. One of the indoor air samples could be collected in or near an attached garage to evaluate whether any BTEX compounds are homeowner-related or site-related. Four 24-hour soil gas samples would be collected from each targeted residence for a total of 100 soil gas samples. All soil gas samples would be collected from depths that are close to the foundation depth of each home and as close to the homes as possible. Soil sampling would be conducted at locations where groundwater sampling results do not correlate with soil gas sampling results. Thus, in order to determine whether there were any homeowner-related spills during a sampling period and for the purposes of this FS, it is assumed that one soil sample from a depth of two feet bgs would be collected from each soil gas sample location. Shallow groundwater samples from two intervals (35' - 40' and 40' - 45' bgs) would also be collected at about 10 locations (approximately 40 percent of the targeted homes) during each sampling period in order to correlate groundwater concentrations with soil gas results.

All samples associated with the monitoring of the vapor intrusion pathway would be analyzed for VOCs including PCE, TCE, benzene, ethylbenzene, toluene, xylenes, acetone, methylene chloride, Freon 113, 2-butanone (methyl ethyl ketone), 1,1,1-TCA, cis-1,2-DCE and other breakdown products of PCE and TCE. The soil gas and indoor air monitoring could continue for two years until baseline indoor air and soil gas concentrations are established. This alternative assumes that monitoring of the vapor intrusion pathway would continue for five more years at approximately 10 homes or until it is confirmed that soil gas is not a threat. The frequency of sampling and the number of soil gas and indoor air samples and the soil and the shallow groundwater samples as well as sampling protocols would be similar to that used during the first two years.

Clearing, Grubbing, and Site Preparation

Minimal clearing, grubbing, and site preparation would be required for installation of the extraction wells and the associated treatment buildings. It is estimated that clearing and site preparation would last approximately one day at each treatment building location. This assumes that the U.S. EPA will be able to procure the land for siting the treatment buildings and necessary easements for the effluent pipeline.

Pump-and-Treat System

This alternative would use a pump-and-treat system to meet groundwater RAOs. A total of 23 extraction wells spaced throughout the extent of the plume would be used to aggressively remove contaminated groundwater from the plume. Figure 4-1 indicates the locations of the extraction wells, transfer piping, treatment buildings, and the outfalls for discharging the treated groundwater. The contaminated groundwater would be first withdrawn using extraction wells and then treated in an aboveground treatment system. The various treatment systems would discharge to either the Dry Creek or the Rock River. Discharges at either location would meet the substantive requirements of NPDES permit and the Illinois effluent standards. A typical process flow schematic of the pump-and-treat system with air stripping is depicted in Figure 4-2.

The approximate extraction well spacing and pumping rates were determined with a capture zone analysis. The capture zone analysis was conducted by creating a groundwater flow model using the USGS computer code, MODFLOW. The Boss GMS, Version 3.1, software was used as a pre- and post-processor for MODFLOW. The site area modeled included the area within the contaminated groundwater plume representative of the VOC contamination extent observed during the 2000 RI and the 2002 Investigation and a flow system that approximated the existing hydraulic gradient across the site.

The groundwater model covered an area 10,500 feet by 17,000 feet, and used a uniform grid spacing of 50 feet. The model used two aquifer layers, both depicting the sand and gravel aquifer with a hydraulic conductivity of 3.8×10^{-2} cm/sec, as presented in the GDER, Revision 1 (WESTON, 2003). Both layers were modeled as 100 feet thick; however, only the saturated thickness of the uppermost layer was used in the flow calculations. The upper layer ranged in saturated thickness from 65 feet near the Rock River to 88 feet at the northern boundary, depending on the steady state water table elevation. The northern, or upgradient, boundary was modeled as a general head boundary, which allowed water to enter the system at a controlled rate, similar to natural conditions. The Rock River served as the southern, or downgradient model boundary. The Rock River was modeled using river nodes in the upper layer only. The eastern and western boundaries were modeled as no-flow boundaries, perpendicular to the direction of flow. The initial water table surface was modeled to have a gradient of 0.0015 ft/ft, as presented in the GDER, Revision 1 (WESTON, 2003).

Wells were added to the uppermost layer of the model and assigned various pumping rates, effectively mimicking partial penetration of wells. Particle tracking in the upper layer was performed using the MODPATH code through the Boss GMS, Version 3.1, pre- and post-processor software. Particle tracking was run in a backward fashion to estimate the radius of influence of a pumping well over a given period of time. Particles were located along the perimeter of the grid cells containing pumping wells. A specific yield/storativity value of 30% was used in particle tracking simulations. Various well layouts and pumping rates were simulated until an acceptable array of wells was obtained.

A well layout capable of approximately capturing the groundwater within the plume footprint area included 23 wells, each pumping at a rate of 500 gpm. Appendix C contains various figures associated with the capture zone analysis as well as water budget information supporting the model.

The Wellhead Protection Area (WHPA) delineation software (U.S. EPA, 1992) (full reference: U.S. EPA, 1992, WHPA - A Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas, version 2.1) was used in check the results obtained from MODFLOW. The WHPA software was used to model the extent of pumping influence for one of the wells proposed in the capture zone analysis. Although, WHPA is capable of calculating the extent of pumping influence over a given time period, it cannot simulate the effects of partial penetration of wells. Because partial penetration cannot be simulated with WHPA, the simulation was run using saturated thicknesses of 70 and 170 feet. The 70 foot thickness approximately corresponds to the upper layer in the capture zone analysis and the 170 foot thickness approximately corresponds to the full saturated thickness used in the capture zone analysis. The smaller saturated thickness is expected to overestimate the radius of influence while the larger saturated thickness is expected to underestimate the radius of influence. However, these results were intended to bracket the range of the expected radius of influence. Other input parameters for the simulation included a pumping rate of 500 gpm, a hydraulic conductivity of 3.8×10^{-2} cm/sec, a specific yield of 30%, and a pumping duration of 730 days (2 years). The results of the two WHPA simulations yielded a radius of influence that was between 650 and 1,000 feet. This range compares favorably with the output from the capture zone analysis performed with MODFLOW. Output from the two WHPA simulations is included in Appendix C.

The CAPZONE software code (Bair, et.al., 1992) (full reference: Bair, E. Scott, Abraham E. Springer, and George S. Roadcap, CAPZONE - An Analytical Ground-Water Flow Model, version 1.1, Ohio State University, Department of Geological Sciences, March 1992) was used to estimate the expected drawdown at the extraction wells. Input parameters were similar to those used for the WHPA simulations and included both the 70 and 170 foot saturated thicknesses. The result of pumping the smaller saturated thickness aquifer (70 ft) resulted in drawdown exceeding 25 feet. The result of pumping the thicker aquifer(170 ft), resulted in a drawdown of approximately 21 feet in the pumping well.

Based on the results of the 2000 and the 2002 investigations, the area of the contaminated groundwater plume area is approximately 555 acres (24.2 million ft^2) and the aquifer thickness is 70 ft with an average porosity of 30%. This yields approximately 3.8 billion gallons of contaminated water within the plume. The 23 extraction wells would pump at a total rate of 11,500 gpm (about 6 billion gallons per year) for approximately 2 years to extract all the contaminated water from within the plume. If this alternative is selected as the final remedy, aquifer pump tests and additional groundwater modeling would be required to finalize the design parameters for the extraction system.

Transfer pipes connecting the extraction wells to the treatment building and from the treatment buildings to the outfalls would be buried in the right-of-way (ROW) and/or on private properties and registered with the Roscoe Township such that they may be entered into the state utility database. The pipelines would be buried at least 3 ft deep for frost protection. The outfalls would require stabilization (i.e., using rip rap) to prevent erosion. The discharge pipe outlet would also require adequate protection from damage.

Air Stripping

Air stripping is a mass transfer process where volatile organic contaminants in the liquid phase are transferred into an air stream. Air stripping contacting systems increase the surface area of the contaminated water that is exposed to air to more rapidly partition the contaminants from the groundwater. An air stripping unit can be designed in a number of configurations including packed towers, diffused aeration, tray aeration, and spray aeration. The most common configurations are the packed and tray towers. In packed and tray tower aeration, mass transfer of VOCs from water to the air is facilitated by mixing contaminated water and air in a countercurrent flow pattern. Contaminated water is first pumped to the top of the column, and then distributed, and trickled down through a bed of packing material or over trays. Air is blown in or drawn from the bottom of the column. The packing material and trays provide a large surface area to mix air and water, adequate contact time for the VOC molecules to transfer states from water to air, and a large void volume to reduce the air system energy loss.

The degree to which a COC enters the gaseous phase would depend on a combination of physical/chemical characteristics of the constituent such as Henry's Law constants, diffusivity, molecular weight, solubility, and vapor pressure as well as system design. The greater the Henry's Law constant for a particular VOC, the greater its removal from water by aeration. Air stripping is effective in removing VOCs having Henry's Law constants greater than 3.0×10^{-3} atm-m^3/mole. The Henry's Law constant for PCE and TCE range from 2.9×10^{-3} to 1.5×10^{-2} atm-m^3/mole, and from 9.1×10^{-3} to 1.2×10^{-2} atm-m^3/mole (Montgomery and Welkem, 1991), respectively. Based on the Henry's law constants for PCE and TCE, air stripping will be an effective treatment process for groundwater at the Evergreen Manor Site. Since the Henry's Law constant increases with temperature, the removal rate of a contaminant via aeration increases at higher temperatures. Based on the type of VOCs present, their relative concentration, and the assumed flow rates of 500 gpm, it is assumed that each air stripper would require blowers with capacities between 100 and 300 standard cubic feet per minute (scfm).

All treatment system components would be housed in a heated building. Air monitoring would be needed during system setup to verify that there are no fugitive emissions. After the system is setup, monthly air monitoring using an organic vapor monitor (OVM) would be conducted for system components during routine maintenance.

Pre-treatment would consist of a bag filter or an in-line screen to remove solids. Based on the low mass of volatile organic matter (VOM) that would be emitted (approximately 100 pounds per year) as estimated in Appendix E, off-gas treatment is not anticipated at this time. However, if required, a suitable off-gas treatment would be easily implementable. Initial air monitoring at the stack and the property line may be required to demonstrate that emission controls are not warranted. Air containing VOCs would be captured and treated, if necessary, using vapor phase carbon adsorption.

Air strippers would require periodic cleaning to remove scaling. Additionally, small quantities of metal (i.e., iron) sludge may require removal and disposal. Water treated by the treatment system would be discharged either to the Dry Creek or to the Rock River. Water will be discharged in accordance with the substantive requirements of a NPDES permit issued under the Clean Water Act and the Illinois Effluent Standards. appropriate regulations.

Verification samples from the influent and effluent streams of the air stripper would be collected on a quarterly basis to determine system loading and operating conditions and to ensure compliance with the permit effluent requirements.

Estimated Time to Achieve Groundwater RAOs

The estimated time to achieve RAOs for groundwater is dependent on several factors including the time needed for the COCs to travel from the furthest contaminated area to the extraction wells, presence or absence of immiscible contaminants in the subsurface, porosity and hydraulic conductivity of the aquifer, tailing effects and retardation of contaminants, and other constraints such as adsorption, preferential pathways, or low permeability zones. Based on the results of the 2000 and the 2002 investigations, the area of the contaminated groundwater plume area is approximately 555 acres (24.2 million ft^2) and the aquifer thickness is 70 ft with an average porosity of 30%. This yields approximately 3.8 billion gallons of water within the plume. Based on the results of preliminary groundwater modeling, discussed previously, 23 extraction wells, each pumping at a rate of 500 gpm, would be required to extract one pore volume (PV) of water which is the volume of groundwater with the known contamination plume.

Aquifer restoration requires that sufficient groundwater be flushed through the contaminated zone to remove both existing dissolved contaminants and those that will continue to desorb from porous media, dissolve from precipitates or NAPL, and/or diffuse from low permeability zones. Assuming linear, reversible, and instantaneous sorption, no NAPL or solid contaminants, and neglecting dispersion, the theoretical number of PVs required to remove a contaminant from a homogeneous aquifer is approximated by the retardation factor, R, which is the ground-water flow velocity relative to the contaminant velocity rates. Retardation factors for PCE and TCE were calculated to be approximately 1.34 and 1.97, respectively. Using these retardation factors, the theoretical number of PVs required for achieving the PCE and TCE MCL of 5 ug/L were calculated to be approximately 3.36 and 4 PVs, respectively. Detailed calculations for retardation factors and PVs are presented in Appendix D. Based on the foregoing discussion, approximately four PVs of contaminated groundwater would be extracted and treated. Therefore, the time required to achieve the RAOs would be approximately 8 years. However, the source(s) of contamination, whether multiple sources, extraneous sources, point source or continuing source, remain unknown, and additional effort may be warranted to address this issue. Also, a certain amount of uncertainty remains with respect to the current horizontal and vertical extent of the Evergreen Manor plume, and the remaining contaminant concentrations within the plume. If sources are present and if the horizontal and vertical extent of contamination is larger than currently known, the time required to achieve the RAOs may be longer than predicted.

Monitoring and Extraction Well Installation

This alternative assumes that a total of six new monitoring wells would be installed. The location of these monitoring wells would be based on results of additional site characterization conducted during the pre-design phase. Additional site characterization required prior to implementation of this alternatives is discussed later in this subsection. In addition to the monitoring wells, 23 extraction wells will be installed. Proposed locations for the extraction wells are depicted on Figure 4-1. The exact location and number of extraction wells would be based on aquifer pump tests and detailed groundwater modeling conducted during the pre-design phase.

Contingency Plan

In order to address changes in land and groundwater use and/or changes in groundwater or soil vapor conditions, possible contingency actions under this alternative would include:

- Confirmation sampling.
- Collecting sample more frequently.
- Collecting surface water and/or sediment samples from the Rock River.
- Installing new monitoring wells.
- Adding locations to the vapor monitoring program.
- Adding private wells to the groundwater monitoring program.
- Notifying the Winnebago County Health Department of changes in the extent of the contaminated groundwater plume and of any changes in chemical concentrations within the plume.
- Installing venting systems at homes with hazardous levels of site-related vapors.
- Modifying the pumping rate(s) of the extraction wells.

- Evaluating whether additional response actions, such as constructing additional extraction wells, installing treatment units at individual private wells, or connecting additional homes to the NPPWD are necessary.

- Implementing additional response actions.

Additional Characterization

Additional characterization would be conducted to address the data gaps and uncertainties identified in Section 1 of this report and Sections 6 and 8 of the GDER, Revision 1 (WESTON, 2003) and the Air Sampling Report, Revision 3 (WESTON, 2003), respectively. These additional characterization activities would be needed during the pre-design phase prior to implementing the remedial alternative. The following characterization activities would be conducted in order to identify the source area and delineate the horizontal and vertical extent of groundwater contamination:

- All private wells within the plume site boundary (as determined by the historical maximum extent of VOCs) and in nearby areas would be sampled to confirm that these wells are not impacted. Sampling would be conducted at approximately 9 locations along Metric Road, 19 locations along East Rockton Road, 12 locations along Route 251/2nd Street, 19 locations along Degroff, 4 locations along McCurry, and 10 locations along Stamford Lane and Waltham Road.

- The current monitoring well network may not be appropriately located to accurately determine the groundwater flow direction. Confirming the groundwater flow across the site would help identify areas where groundwater contaminants may remain. Groundwater flow would be determined by installing approximately 11 piezometers at locations shown in Figure 4-3. Groundwater elevation data from the piezometers would be used to supplement groundwater elevation data from the existing groundwater monitoring well network.

- In order to monitor the remaining groundwater contamination, and identify the extent and concentrations of the remaining groundwater contamination, the existing monitoring wells would be evaluated to determine whether they are appropriately located. Evaluation would be conducted via vertical profiling in the nearby area of existing well locations to confirm the extent of any remaining contamination.

Groundwater flow directions and private well sampling would also be used to help target areas where groundwater contaminants may remain. Vertical profiling would be conducted in the vicinity of the following areas:

- MW-103, MW-107, MW-108, MW-109 (10 locations)
- Degroff Street, MW-101, and unsampled CPT-07, CPT-08 and CPT-13 (6 locations)
- Between CPT-05 and CPT-10 and CPT-10 and CPT-06 (4 locations)
- In the subdivisions to determine current concentrations in the center of the plume and to confirm plume boundaries (15 locations)
- On the other side of the Rock River to confirm there is no underflow and contaminant transport to the other side of the Rock River (5 locations)

The actual number of vertical profiling locations could be more or less and would depend on the results of initial vertical profiling locations:

• Approximately three additional shallow monitoring wells and three additional deep monitoring wells may be installed to identify horizontal and vertical areas where additional monitoring wells would be needed for any long-term monitoring programs. The actual number of monitoring wells needed would depend on the results of the pre-design investigations.

The extent of soil gas and shallow groundwater contamination would be characterized throughout the subdivisions. The initial characterization activities would include homes in areas that, historically, have had the highest levels of groundwater contamination (e.g., those along the centerline of the plume), homes in areas where relatively lower level of contamination has been observed, and homes that lie outside the plume. Soil gas sampling in addition to groundwater sampling can help identify areas where vapors may collect or be channeled, even if groundwater concentrations are low (e.g., homes on Wagon Lane Court). Soil samples can be collected adjacent to soil gas samples to differentiate contamination from groundwater and contamination from household sources (e.g., spilling gasoline from a lawn mower). The characterization activities would be conducted during pre-design and would include:

- Soil gas and shallow groundwater sampling at approximately 50 locations within the subdivisions (20% of homes) to determine the nature and extent of any shallow groundwater and soil gas contamination. The actual number of locations could be more or less and would depend on the results of initial soil gas and groundwater results. Approximately three soil gas samples would be collected at each sampling location – one just above the water table, one consistent with the bottom of the home's foundation (about 8 ft) and one in between. Approximately two groundwater samples would be collected at each location – one at the water table and one in the interval below.

- Soil sampling would be conducted at locations where groundwater sample results do not correlate well with soil gas sample results to determine whether there are any homeowner-related spills. Assuming that 20 percent, or 10 of the 50 homes sampled would have questionable results, a total of 50 soil samples would be collected from 10 homes. Further, it is assumed that each soil sample would be collected from depths of two feet, four feet, six feet, eight feet and ten feet bgs.

- Based on the results of the soil gas and shallow groundwater characterization, additional soil, soil gas, and shallow groundwater samples would be collected in the vicinity of selected septic systems to determine whether the septic system is a source of contamination. It is assumed that 20 percent, or 10 of the 50 homes sampled would need septic characterization. Each septic characterization would include three adjacent soil gas samples, three adjacent soil samples and two shallow groundwater samples. All soil and soil gas samples would be collected from the following depths: above the water table, at a depth that is consistent with the depth of the septic system, and one in between. Septic systems, used by most, if not all of the Evergreen Manor subdivision residents, may be a point-source of certain contamination (e.g., use of chemicals to unclog a drain). However, it should also be noted that, prior to the municipal well-hookup, household water obtained from contaminated private well supplies was discharged to septic systems.

4.2.2.2 Detailed Analysis of Alternative 2

Alternative 2 is assessed based on the nine criteria in the following paragraphs.

<u>Overall Protection of Human Health and the Environment</u>

This alternative would reduce exposure to groundwater COCs by human receptors through groundwater use and access restrictions. This alternative would also reduce the human health risk associated with exposure to the COCs via treatment of the contaminated groundwater.

The contaminated groundwater would be extracted, treated on-site, and discharged either to the Dry Creek or to the Rock River. Present and future risk due to COCs present in the groundwater would be reduced over time as the contaminants migrate toward the extraction wells. The time required to achieve the RAOs is estimated to take approximately 8 years.

Monitoring of groundwater would ensure that the treatment system is effective in capturing the contaminant plume and that concentrations of COCs are decreasing until the RAOs are achieved. Additionally, as the levels of contaminants in the groundwater decrease, the levels of site-related contaminants in the soil gas and in area homes are expected to decrease. Monitoring of the vapor intrusion pathway would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health via the vapor intrusion pathway. Contingency plan associated with this alternative would address changes in land and groundwater use and/or changes in groundwater or soil vapor conditions. If the alternative is not performing as anticipated, if site conditions change to the extent that this alternative is no longer protective, or if the vapor intrusion pathway is found to be a threat, appropriate contingency actions would be implemented to ensure that the human health and environment remain protected. Overall, this alternative would provide adequate protection of the human health and environment.

<u>Compliance with ARARs</u>

Table 4-1 lists potential ARARs for the remedial alternatives and whether implementation of the alternatives would meet the ARARs. Alternative 2 complies with all potential ARARs identified in Appendix A. The groundwater treatment system would be designed and constructed so that all applicable action-specific ARARs are met. Air discharges will be treated, if necessary, to meet the substantive requirement of the appropriate permit. Discharge of the treated groundwater to the Dry

Creek and Rock River would be in accordance with the substantive requirements of a NPDES permit and would meet all applicable discharge standards.

Long-Term Effectiveness and Permanence

The contaminated groundwater would be extracted, treated on site, and discharged to the Dry Creek or the Rock River. The extraction of the groundwater would create a hydraulic barrier and prevent the contaminated groundwater from entering the river. The residual risk to human health and the environment associated with groundwater contamination would decrease over time through extraction and treatment. It is estimated that it will take approximately eight years to reduce concentrations of COCs in the groundwater to below MCLs and to achieve RAOs for groundwater. Upon attainment of RAOs, remedy would be permanent unless a continuing or secondary source exists. Although residual concentrations of PCE and TCE may exist in the aquifer after RAOs are attained, the level of risk presented by these constituents would be below the 1.0E-6 "point of departure" that the U.S. EPA considers to be acceptable. However, groundwater monitoring would be required for several years after RAOs are met to ensure that levels do not rebound due to contribution from a continuing or secondary source.

The site access and groundwater use restrictions would be effective if properly maintained and enforced. Access and groundwater restrictions would be temporary and in place until RAOs are achieved. Results of groundwater monitoring and the vapor intrusion pathway would be used to determine that adequate containment is achieved, to verify that concentrations of COCs are decreasing, and to determine the time needed to achieve the RAOs for groundwater.

Groundwater extraction and air stripping are established technologies for groundwater remediation. Periodic review and modification of the treatment system design, construction, maintenance, and operation of the system will be necessary. Groundwater monitoring would be conducted, and the extraction system would be adjusted accordingly in order to effectively capture the contaminated groundwater plume. The treatment system will require regular maintenance due to scaling and equipment failures. Other components of the treatment system, such as pumps, valves, piping, gaskets, etc., would be checked periodically for leaks and proper maintenance (e.g., lubrication, belts, etc.)

Some treatment residuals may be produced if pretreatment or post-treatment is required in order to protect equipment or meet air and/or water discharge requirements. The treatment residuals would pose minimal risk and would be disposed of in accordance with all applicable requirements.

Reduction of Toxicity, Mobility, and Volume Through Treatment

Extraction and air stripping of the groundwater would reduce the toxicity and volume of contamination over time. No reduction in contaminant toxicity is achieved directly as air stripping would only transfer the VOCs from water to air. However, chlorinated VOCs are photooxidized in the atmosphere so they would ultimately be destroyed by environmental processes independent of the remedy. The extraction of the groundwater would prevent the contaminant plume from expanding and entering the Rock River, thereby reducing the mobility of the contaminants.

Upon attainment of RAOs, remedy would be permanent unless a continuing or secondary source exists. Limited quantities of residuals in the form of sludge from precipitation and spent filters may be generated.

Short-Term Effectiveness

The installation of the alternate water supply has already mitigated the short-term effects to site receptor populations. Monitoring of groundwater would ensure that the treatment system is effective in capturing the contaminant plume and that concentrations of COCs are decreasing. Monitoring of the vapor intrusion pathway would help identify sources of VOCs observed in soil gas and indoor air as well as help monitor the potential risk to human health via the vapor intrusion pathway. Contingency plan associated with this alternative would address changes in land and groundwater use and/or changes in groundwater or soil vapor conditions and thus ensure adequate protection of the community and workers.

Implementation of this alternative would result in temporary increase in noise, truck traffic, and dust generation during construction of treatment building, piping, and installation of extraction wells. Noise from construction activities would be controlled by conducting these activities during daytime hours and giving due consideration to the residents. The community would not be exposed to the hazards of the groundwater during off-site disposal.

Workers would follow appropriate health and safety measures to prevent exposure to COCs during construction activities. Implementation of appropriate health and safety measures will ensure worker protection. There is a potential for workers to be exposed to airborne VOCs volatilized from groundwater during the start-up and operation of the groundwater remediation system due to fugitive emissions. Health and safety air monitoring would be conducted during start-up of the treatment system and during routine maintenance checks of the equipment to mitigate this risk.

There is a potential for increased runoff and runon during construction activities. In addition, noise and dust generation are possible due to operation of heavy equipment. Implementation of appropriate construction safeguards would mitigate these risks.

The estimated time to achieve groundwater RAOs is approximately eight years. However, since the predicted time is based on numerous assumptions regarding site geology, hydrogeology, and contaminant migration characteristics, it may not be the actual time frame for achieving RAOs. Also, the source(s) of contamination, whether multiple sources, extraneous sources, point source or continuing source, remains unknown, and additional effort may be warranted to address this issue. Additionally, a certain amount of uncertainty remains with respect to the current horizontal and vertical extent of the Evergreen Manor plume, and the remaining contaminant concentrations within the plume. If sources are present and if the horizontal and vertical extent of contamination is larger than currently known, the time required to achieve the RAOs may be longer than predicted. Although not anticipated, the presence of a source area may have severe adverse effects on the effectiveness of the remedy. This may increase the time required to attain the RAOs.

Implementability

Institutional controls including groundwater monitoring and groundwater restrictions and the vapor intrusion monitoring program would be easy to implement. Based on known site geology, the installation of extraction wells would be easy to implement. The pump-and-treat system would be easy to construct since equipment, materials, trained personnel, contractors, and suppliers are readily available; however, operation and maintenance of the equipment will be required. The major implementability issue with the pump and treat system would be associated with the operation and maintenance of the system. Typical operation problems for the pump-and-treat system stem from the failure of surface equipment, electrical and mechanical control systems, biofouling or chemical precipitation causing plugging of wells, pumps, surface plumbing, and the air stripper. Regular maintenance would mitigate operating problems; however, maintenance would entail a significant amount of effort. Land acquisition for the treatment buildings and associated piping may entail some difficultly. Discharge of stripper emissions and treated water would require permits, which would be relatively easy to arrange.

If additional remedial actions are needed to treat the environmental media at the site, future remedial actions could be easily implemented. The discharge permit would be relatively easy to obtain and would set the effluent requirements for the treatment system. Verification samples of the treated groundwater would ensure that permit requirements are met. The pump-and-treat system is an established technology that has been implemented at numerous sites for remediation of VOCs in groundwater. The pump-and-treat system would be easy to construct, install, and operate; however, frequent maintenance and monitoring would be required. Materials and services required to construct and operate this system are readily available.

Cost

The cost to implement Alternative 2 was estimated to be $25,088,000. This estimated cost includes capital/construction costs of $12,844,000 and a present worth O&M cost of $12,244,000. The estimated costs do not include restoration activities that would occur after the cleanup is complete. These costs were not included primarily due to the uncertainty associated with the presence of a source and the consequent remedial time frame. Table 4-2 presents a summary of costs associated with Alternative 2. A detailed cost estimate is provided in Appendix F.

State Acceptance

The alternative will be evaluated for this criterion following U.S. EPA receipt of formal comments regarding the FS Report and U.S. EPA's proposed plan from all federal and Illinois agencies that have interest in the site.

Community Acceptance

This criterion will be evaluated after U.S. EPA receives formal comments from the community.

4.2.3 Alternative 3: Institutional Controls for Air (Vapor Intrusion) and Groundwater and Monitored Natural Attenuation (MNA) of Contaminated Groundwater

4.2.3.1 Detailed Description of Alternative 3

Alternative 3 consists of institutional controls including monitoring of the vapor intrusion partway, groundwater monitoring and restrictions on groundwater use, and monitoring and evaluation of groundwater contaminant degradation rates and pathways. A detailed discussion of the major components associated with this alternative is presented in the following text.

TCE/PCE groundwater cleanup levels would be achieved by monitored natural attenuation. Natural attenuation relies on natural subsurface processes such as dispersion, advection, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials to reduce contaminant concentrations. The overall decrease of the contaminated plume, favorable site conditions, contaminants amenable to natural attenuation substantiated by overall decrease in concentrations, presence of PCE upgradient possibly breaking down to TCE downgradient, and presence of numerous daughter products at low levels throughout the plume and other site-specific data presented in this report, appears to indicate that monitored natural attenuation (MNA) would be an effective alternative at the Evergreen Manor site.

The natural attenuation of COCs at the Evergreen Manor site is primarily due to dispersion, advection, and possibly due to biodegradation.

<u>Groundwater Use Restrictions</u>

The Hononegah Heights, Evergreen Manor, Tresemer and Old Farm subdivisions are part of Roscoe Township. Roscoe Township is located within the North Park Public Water District (NPPWD), however, not all residences within these subdivisions receive their water from the NPPWD. Prior to 1999, the residences within the subdivisions obtained their water from private residential wells. Based on limited well construction data available for review, these residential wells were completed within the shallow sand and gravel outwash deposits at average depths of 55 to 65 feet bgs, with depths ranging from 43 feet to 105 feet bgs. Due to the VOC-affected groundwater in the shallow aquifer related to the Evergreen Manor site and the Warner Electric RCRA site, many of the residences in the area are connected to the NPPWD water supply system, and private wells associated with these homes have been abandoned.

Between 1999 and 2000, the U.S. EPA connected a total of 262 residences located within the Evergreen Manor site to the NPPWD water supply. In addition, 19 of 21 homes included in a "buffer zone" were connected to the NPPWD water supply as a precaution. These residences are depicted on Figure 1-5. It should be noted, however, that due to the uncertainties associated with the exact addresses not all residences connected to the NPPWD are shown. At the request of the current landowners, two homes located within the southern perimeter of the "buffer zone" were not connected to the NPPWD water supply. As shown in Figure 1-5, these two residences are located outside of the eastern boundary of the contamination plume. In May 2001, five residences located adjacent to the contamination plume, including one which had previously declined to be connected to the NPPWD water supply, were sampled by the IDPH. The results of this sampling indicated that the groundwater in the vicinity of these residences has remained unaffected by the site contamination. Upon review of the NPPWD service records, it is apparent that additional residences and/or commercial properties within the vicinity of the Evergreen Manor Site may be using private wells for potable water. These locations are depicted on Figure 1-6.

Groundwater use at the site would be restricted during remediation until RAOs are met. An alternate water supply system is already in place. To reduce the likelihood of exposure to the contaminated groundwater beneath the Evergreen Manor site, Winnebago County has implemented an ordinance that requires all residences to be connected to a public water supply system if they are within 200-feet of a system. In addition, the county requires property owners to obtain well permits for new or existing well repairs. This permit provides the county the opportunity to notify the applicant about the location of a contamination plume and provide recommendations for additional water treatment, as well as require new wells to be drilled to depths believed to be beneath a contamination plume.

Groundwater Monitoring

In order to determine any change in the previously identified plume, any change in the vertical profile of the contaminant concentrations, and any overall change in contaminant concentration, this alternative assumes that groundwater monitoring assumes that groundwater monitoring would be conducted for 15 years. Under this alternative, a total of 30 monitoring wells including 20 new and 10 existing monitoring wells would be sampled and analyzed for VOCs until RAOs are achieved. All monitoring wells would be sampled on a quarterly basis for the first five years, semi-annually for the next five years, and annually for the remaining five years. The actual number of monitoring wells and frequency of sampling would be determined during the remedial design phase and would be based on results of additional site characterization and groundwater modeling conducted during the pre-design phase. Additional site characterization required prior to implementation of this alternatives is discussed later in this subsection.

In order to monitor the impact of groundwater plume on private wells, this alternative assumes that 10 private wells would be sampled and analyzed for VOCs until the RAOs are achieved. These private wells would be sampled on a quarterly basis for the first five years, semi-annually for the next five years, and annually for the remaining five years. The actual number and frequency of private wells would be determined during the remedial design phase and would be based on results of additional site characterization and groundwater modeling conducted during the pre-design phase. Additional site characterization required prior to implementation of this alternatives is discussed later in this subsection.

Monitoring of Vapor Intrusion Pathway

This component of Alternative 3 would be the same as that described for Alternative 2.

Estimated Time to Achieve Groundwater RAOs

The TCE and PCE concentration trends discussed in Section 1 and depicted in Figures 1-10 and 1-11, respectively, suggest that both TCE and PCE are undergoing natural decay that follows first-order kinetics. Using this model, the TCE concentration of 7.2 μg/L, observed in monitoring well MW-03 in 2002, could decline to less than 5 μg/L in approximately 1.5 years. Similarly, it was projected that by following the PCE attenuation rate observed in monitoring well MW-103S, the 2002 PCE concentration of 5.9 μg/L, observed in monitoring well MW-03, could decline to less than 5 μg/L in approximately 3 years. Results of the foregoing first order kinetics are consistent with the results of the RI which concluded that constituent concentrations, will continue to decline, primarily due to dispersion, advection, and possibly due to biodegradation, and ultimately decline below MCLs. During the 2000 RI, the BIOSCREEN model was used to estimate the time frame during which COPC concentrations would decline below MCLs. The model results predicted that TCE concentrations would reduce below the MCLs in about 6 years and PCE concentrations would reduce below the MCLs in about 15 years. Although the expected TCE attenuation rate predicted by the BIOSCREEN model is similar to the attenuation rate predicted by the kinetic model, the PCE attenuation rates predicted by the two models vary significantly. For the purposes of this FS, it is conservatively assumed that under MNA, TCE concentrations would reduce below the MCLs in about 6 years and PCE concentrations would reduce below the MCLs in about 15 years. Thus, this alternative would be able to achieve the RAOs in approximately 15 years. However, the time required to achieve the RAOs would be longer if a source area is present or if the horizontal and vertical extent of contamination is larger than currently known.

Monitoring Well Installation

This alternative assumes a total of 20 new monitoring wells would be installed. The location of these monitoring wells would be based on results of additional site characterization conducted during the pre-design phase. Additional site characterization required prior to implementation of this alternatives is discussed below.

Contingency Plan

In order to address changes in land and groundwater use and/or changes in groundwater or soil vapor conditions, possible contingency actions under this alternative would include:

- Confirmation sampling.
- Collecting sample more frequently.
- Collecting surface water and/or sediment samples from the Rock River.
- Installing new monitoring wells.
- Adding locations to the vapor monitoring program.
- Adding private wells to the groundwater monitoring program.
- Notifying the Winnebago County Health Department of changes in the extent of the contaminated groundwater plume and of any changes in chemical concentrations within the plume.
- Installing venting systems at homes with hazardous levels of site-related vapors.
- Evaluating whether additional response actions, such as constructing a groundwater pump and treat system, installing treatment units at individual private wells, or connecting additional homes to the NPPWD are necessary.
- Implementing additional response actions.

Additional Characterization

This component of Alternative 3 would be the same as that described for Alternative 2.

4.2.3.2 Detailed Analysis of Alternative 3

Alternative 3 is assessed based on the nine criteria in the following paragraphs.

Overall Protection of Human Health and the Environment

The monitored natural attenuation alternative protects human health and the environment by using natural processes such as recharge, stream capture, dilution, dispersion and degradation to reduce chemical concentrations in the groundwater to drinking water levels and to minimize further spreading of the contaminant plume. The Rock River is capturing groundwater contaminants, where they become diluted and dispersed and will not contaminate drinking water supplies. Additionally, as the levels of contaminants in the groundwater decrease, the levels of site-related contaminants in the soil gas and in area homes are also expected to decrease. The monitored natural attenuation alternative also includes institutional controls to prevent people from using the contaminated groundwater until the cleanup levels are attained; monitoring to track and evaluate the effectiveness of natural attenuation and to ensure its protectiveness over time; monitoring to ensure that the vapor intrusion pathway is not a threat. Additionally, it includes contingency actions that would be implemented if the natural cleanup processes are not performing as anticipated, if site conditions change to the extent that these processes are no longer protective, or if the vapor intrusion pathway is found to be a threat.

Compliance with ARARs

Table 4-1 lists potential ARARs for the remedial alternatives and whether implementation of the alternatives would meet the ARARs. Alternative 3 would meet chemical-specific ARARs, such as MCLs, over time. Based on historical data analysis, it is expected that MNA processes would reduce TCE and PCE concentrations to below MCLs. Groundwater monitoring would be conducted to determine TCE and PCE concentrations are attenuating and confirm that adequate reduction is occurring.

Long-Term Effectiveness and Permanence

Alternative 3 provides long-term effectiveness and permanence by using natural processes to permanently remove groundwater contaminants from the groundwater and/or to permanently disperse groundwater contaminants or transform them into less-toxic chemicals. Additionally, as the levels of contaminants in the groundwater decrease, the levels of site-related contaminants in the soil gas and in area homes are also expected to decrease. This alternative would return the contaminated groundwater to its use as a drinking water supply and offers a high degree of long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, and Volume through Treatment

Under current conditions and the conditions observed at the site since 1990, Alternative 3 would provide for some reduction of toxicity, mobility or volume through natural treatment processes, since the presence of cis-1,2-DCE and other break-down products indicate that some of the contaminants are degrading. However, this degree of biodegradation is not significant.

Short-Term Effectiveness

Alternative 3 would be effective in the short-term since most, if not all of the affected residents have already been connected to the municipal water supply and additional residential well sampling would confirm that no other private well supplies are at risk. This alternative also includes institutional controls to restrict people from using the contaminated groundwater until the groundwater quality improves; monitoring to track and evaluate the effectiveness of the natural cleanup processes and to ensure protectiveness over time, monitoring to ensure that the vapor intrusion pathway is not a threat. In addition, it includes contingency actions that would be implemented if the natural cleanup processes are not performing as anticipated, if site conditions change to the extent that these processes are no longer protective, or if the vapor intrusion pathway is found to be a threat.

The estimated time to achieve groundwater RAOs is approximately 15 years.

Implementability

Long-term groundwater monitoring is easily implementable. Institutional controls including groundwater monitoring and groundwater restrictions and the vapor intrusion monitoring program would be easy to implement. Based on known site geology, the installation of monitoring wells would be easy to implement.

If additional remedial actions are needed to treat the environmental media at the site, future remedial actions could be easily implemented. Detailed contaminant fate and transport modeling would be needed to monitor the effectiveness of natural attenuation. The U.S. EPA approves monitored natural attenuation as a final remedy only after detailed evaluation of the site-specific data is conducted. Based on data evaluation conducted to date, it appears that this alternative would be relatively easy to implement. The only construction activities required are those associated with the groundwater and vapor intrusion pathway monitoring.

Cost

The cost to implement Alternative 3 was estimated to be approximately $8,565,000. This estimated cost includes capital cost of $1,806,000 and a present worth O&M cost of $6,759,000. The estimated costs do not included restoration activities that would occur after the RAOs are attained. These costs were not included primarily due to the uncertainty associated with the presence of a source area and consequent remedial cleanup time frame. Table 4-2 presents a summary of costs associated with Alternative 3. A detailed cost estimate is provided in Appendix F.

State Acceptance

The alternative will be evaluated for this criterion following U.S. EPA receipt of formal comments regarding the FS Report from all federal and Illinois agencies that have interest in the site.

Community Acceptance

This criterion fro Alternative 3 would be evaluated following U.S. EPA's receipt of formal comments regarding the FS Report from the community.

4.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The purpose of the comparative analysis is to evaluate the relative performance of all alternatives using seven of the specific evaluation criteria for which they were analyzed individually in the previous subsections. The State Acceptance and Community Acceptance criteria are excluded from the comparative analysis until formal comments on the FS Report are received from these respective entities. This analysis is performed so that the advantages and disadvantages of the alternatives may be examined relative to each other and so that key differences in the alternatives may be identified, thus providing a framework for selection of an appropriate remedy for the site. The following subsections present the strengths and the weaknesses of the alternatives relative to one another with respect to each criterion and discuss how reasonable variations of key uncertainties could change the expectations of their relative performance.

4.3.1 Overall Protectiveness of Human Health and the Environment

Alternative 1 does not reduce the present or future risk to human and ecological receptors. Alternatives 2 and 3 have similar institutional controls including groundwater monitoring, vapor intrusion pathway monitoring, and groundwater use restrictions. These institutional controls would reduce the exposure risk to human receptors. By using treatment and monitoring, both Alternatives 2 and 3 are equally effective in reducing human health risk arising from exposure to COCs. In addition, both alternatives include similar contingency plans which would ensure that the human health and the environment remain protected.

Alternative 2 captures contaminated groundwater and actively prevents it from moving downgradient and discharging into the Rock River. Alternative 3, on the other hand, will allow the impacted groundwater to move downgradient and/or discharge into the Rock River. Since there is no evidence that surface water or sediment in the Rock River has been impacted by site groundwater, the added benefit of capturing the impacted groundwater is marginal.

4.3.2 Compliance With ARARs

All alternatives except Alternative 1 meet the ARARs.

4.3.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk

For Alternative 1, the No Action Alternative, the magnitude of residual risk would be equal to the present risk. Both Alternatives 2 and 3 provide adequate long-term effectiveness and permanence. The potential for TCE or PCE contamination to rebound after the conclusion of the remedial activities is very low; however, a source area, if it exists it may severely impact the effectiveness of Alternatives 2 and 3.

Alternative 2 would be slightly more adaptable than Alternative 3 in addressing such a condition. Periodic groundwater monitoring after the conclusion of remedial activities may be necessary to evaluate residual TCE or PCE contamination and to confirm that contaminant concentration levels are at or below RAOs.

Alternative 3 relies on natural attenuation, the existing alternate water supply, and groundwater monitoring. Groundwater monitoring is critical for verifying the long-term effectiveness of this alternative. A periodic review may be necessary to verify that the remedy remains protective of the human health and the environment.

For Alterative 2, the residual risk of groundwater contamination would be decreased over time through extraction and treatment. The pump and treat system is an established technology, and the network of extraction wells would actively flush the TCE and PCE in the aquifer and provide for a greater control to account for any changes in the TCE plume direction, depth, or other characteristics. It is estimated that Alternative 2 would require approximately 8 years to achieve the RAOs. Alternative 3 would require approximately 15 years to achieve the RAOs.

Adequacy of Controls

Alternative 1 does not offer long-term effectiveness and permanence because no remedial action is implemented. Alternatives 2 and 3 have similar institutional controls and contingency plans. Institutional controls would be effective if properly maintained and enforced.

The pump-and-treat system and air stripping components of Alternative 2 would require periodic review and modification of the treatment system design, construction, maintenance, and operation whereas natural attenuation in Alternative 3 would require little maintenance other than monitoring. For Alternative 2, a pump test may indicate the need for an additional extraction well which would be an easy addition to implement. Alternatives 2 and 3 would use groundwater monitoring to determine the effectiveness of the treatment components and to determine the time needed to achieve the RAOs for groundwater.

4.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative 1 does not include treatment; therefore, this alternative does not reduce toxicity, mobility, or volume of the COCs/COECs present within the environmental media identified at the site. Alternative 2 transfers TCE and PCE from groundwater to atmospheric air. Based on TCE and PCE concentrations in groundwater, the air emissions are expected to be insignificant (less than 0.1 lb/hr). However, if needed, off-gas treatment can be combined with these alternatives to ultimately destroy the TCE and PCE. Alternative 3 does not include treatment and therefore relies on natural attenuation for toxicity reduction. Whereas, Alternative 3 would directly destroy COCs in the groundwater, Alternative 2 simply transfers the COCs from water to air and relies on environmental processes in the atmosphere to destroy COCs.

4.3.5 Short-Term Effectiveness

Alternative 1 would be effective in the short-term because the site does not pose an imminent danger, and current site risks are manageable without remediation if further time is necessary to select or evaluate alternatives. Alternatives 2 and 3 appear to have similar overall short-term effectiveness. However, close examination of specific aspects of the two alternatives reveal significant differences.

Alternatives 2 and 3 would pose minimal risk to workers, the environment, and the local community during implementation. Due to construction activities associated with treatment building construction, piping, and extraction well installation, Alternative 2 presents greater physical hazards for workers than Alternative 3. Due to vehicular traffic and noise during construction of the treatment system, implementation of Alternative 2 would result in greater risk and disturbance to the community than Alternative 3.

Implementation of Alternative 2 may result in workers being exposed to airborne VOCs that result from fugitive emissions caused by system startup and operation. However, this risk could be easily mitigated by implementing a comprehensive air monitoring program and using appropriate personnel protective equipment. There would be little risk to workers during the environmental monitoring phase of Alternatives 2 or 3.

4.3.6 Implementability

Alternative 1 is the easiest alternative to implement since no remedial activities are required. Alternative 2 would be significantly more difficult to implement than Alternative 3. Both Alternatives 2 and 3 require similar groundwater and vapor intrusion pathway monitoring activities; however, Alternative 2 also requires construction, operation, and maintenance of groundwater pump-and-treat systems.

The pump-and-treat system component of Alternative 2 would be relatively easy to construct, install, and operate. Materials and services required to construct and operate this system are readily available. The pump-and-treat system would require frequent maintenance and review and potential modifications to the system design. Due to limited land availability, acquisition of two pieces of land for two separate treatment systems could be an issue. In addition, appropriate easements would be required for installing the effluent pipeline in the ROW and/or on private properties. Registration of pipelines would also be required to ensure that the pipes are identified by utility locators. Monitoring of the stripper emissions and treated water is easily implementable.

4.3.7 Cost

There is no cost associated with implementation of Alternative 1. The estimated cost to implement Alternative 2 is $25.1 million, and the estimated cost to implement Alternative 3 is $8.6 million. Table 4-2 presents a summary of costs for all the alternatives.

SECTION 5

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Tables

Table 1-1

**Evaluation Criteria for Detected Volatile Organic Compounds
Evergreen Manor
Roscoe, Illinois**

GROUNDWATER

Constituent	U.S. EPA	IEPA	U.S. EPA Ecotox Thresholds[1]	Compendium of Environmental Benchmarks
	Maximum Contaminant Level	Tier I Groundwater Remediation Objective, Class I	Lowest Available Ecotox Threshold	Most Conservative Freshwater Quality Criteria and Guidelines for the Protection of Aquatic Life[2]
	(µg/L)	(µg/L)	(µg/L)	(µg/L)
1,1,1-Trichloroethane	200	200	62	35
Freon 113*	NE	NE	NE	NE
1,1-Dichloroethane	NE	700	47	NE
1,1-Dichloroethene	7	7	NE	11,600**
cis-1,2-Dichloroethene	70	70	NE	200
Chloroform	100	0.2	NE	0.6
Tetrachloroethene	5	5	120	5
Acetone	NE	700	NE	NE
Methylene Chloride	5	5	NE	98
2-Butanone	NE	NE	NE	7200
Benzene	5	5	46	5.9
Toluene	1,000	1,000	130	0.8
Ethylbenzene	700	700	290	8
m- &/or p-Xylene	NE	NE	1.8[#]	2
Xylenes (total)	10,000	10,000	NE	36
Trichloroethene	5	5	350	1

SEDIMENT

Constituent	U.S. EPA Region IX	IEPA	U.S. EPA Ecotox Thresholds[3]	Compendium of Environmental Benchmarks
	Risk Based Concentrations[4]	Tier I Soil Remediation Objective[5]	Lowest Available Ecotox Threshold	Most Conservative Sediment Quality Criteria and Guidelines for the Protection of Aquatic Life[6]
	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
Freon 113*	5600	NE	NE	NE
2-Butanone	7300	NE	NE	NE
Benzene	600	800	57	8
Chloroform	3,600	300	NE	0.4
Methyl Acetate	22,000,000	NE	NE	NE
Toluene	520,000	650,000	670	890

Notes:

NE - Not Established

1. Based on U.S. EPA's Ecotox Update, Ecotox Thresholds, Publication 9345.0-12FSI, EPA 540/F-95/038, January 1996. U.S. EPA chronic ambient water quality criteria (AWQC) or EPA-derived final chronic values (FCVs) (USEPA, 1986a, 1986b, 1987).
2. Based on Appendix 2-4, A Compendium of Environmental Quality Benchmarks, GBEI/BC-99-001 (Environment Canada, 1999)
3. Based on U.S. EPA's Ecotox Update, Ecotox Thresholds, Publication 9345.0-12FSI, EPA 540/F-95/038, January 1996. U.S. EPA sediment quality criteria (SQC) (USEPA, 1993g).
4. Region IX RBCs are based on soil standards for residential property use.
5. Remediation objective is based on soil standard for the inhalation/ingestion exposure route for residential properties.
6. Based on Appendix 3-1, A Compendium of Environmental Quality Benchmarks, GBEI/EC-99-001 (Environment Canada, 1999)

*1,1,2-trichloro-1,2,2-trifluoroethane

** The value is for Total dichloroethenes

[#] The value is for m-xylene

Table 2-1

Total Carcinogenic Risk Associated with Chemical COPC Exposure
Evergreen Manor Site
Roscoe, Illinois

Exposure Route	Total Lifetime Cancer Risk			
	Residential Land Use (Child+Adult)		Commercial/Industrial Land Use (adult)	
	RME	CT	RME	CT
Ingestion	8.6E-06	1.8E-06	2.0E-06	5.1E-07
Dermal absorption	2.2E-06	1.7E-07	1.1E-06	1.0E-07
Inhalation	8.5E-06	2.6E-06	3.8E-06	1.4E-06
Subtotal	1.9E-05	4.6E-06	6.9E-06	2.0E-06

Table 2-2

Total Hazard Index Associated with Chemical COPC Exposure
Evergreen Manor Site
Roscoe, Illinois

Exposure Route	Total Hazard Index					
	Residential Land Use (Child)		Residential Land Use (Adult)		Commercial/Industrial Land Use (Adult)	
	RME	CT	RME	CT	RME	CT
Ingestion	2.0E-01	1.4E-01	8.8E-02	6.1E-02	3.1E-02	2.2E-02
Dermal absorption	2.1E-02	5.2E-03	1.2E-02	3.0E-03	8.5E-03	2.2E–03
Inhalation	3.6	3.6	1.3	1.3	9.5E-01	9.5E-01
Subtotal	3.8	3.7	1.4	1.4	9.9E-01	9.7E-01

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
No Action	No Additional Action	No Action	Consideration required by National Contingency Plan.	Retained
Institutional Controls	Monitoring	Long-term Groundwater Monitoring	Applicable with most alternatives. As a stand-along alternative, applicable to low mobility contaminants or contaminants susceptible to natural degradation.	Retained
	Groundwater Use Restrictions	Groundwater Restrictions	Groundwater use restrictions would restrict the use groundwater.	Retained
	Access Restriction	Access Restriction	Applicable with most alternatives. Not often used as a stand-alone alternative.	Retained
Containment	Vertical Barriers	Slurry Wall	Soil/bentonite slurry is placed in trench to control flow of contaminated groundwater. Requires long-term maintenance and monitoring. Requires treatment or disposal of excavated soil and slurry. Potential to degrade or deteriorate over time. Can be used in conjunction with a treatment technology. Can be installed to depth of approximately 100 ft bgs if geology is suited to application, but will require specialized equipment. Due to sandy nature of soil, this technology would be difficult to implement. Due to the depth of sandy soil underlying the contaminant plume (up to 300 ft), installation of this technology may result in migration of contaminants under the cutoff wall and into deeper portions of aquifer.	Eliminated
		Slurry Columns	Bentonite is mixed into soil with specialized auger equipment. Overlapping borings are drilled in a row to create a barrier. Requires long-term maintenance and monitoring. Potential to degrade or deteriorate over time. Depth of contamination is too deep for this technology to be effective. Due to the depth of sandy soil underlying the contaminant plume (up to 300 ft), installation of this technology may result in migration of contaminants under he cutoff wall and into deeper portions of aquifer.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
		Sealable Sheet Piling	This option is known as the Waterloo Barrier. Uses interlocking joints to form a seal with conventional sheet piling technology. Less site disruption and worker exposure during construction than slurry wall. Depth of contamination is too deep for this technology to be effective.	Eliminated
		Grout Curtain	Grout is injected through tubes placed in closely spaced boreholes. Susceptible to shrinkage and cracking. May not attain complete seal between borings.	Eliminated
Collection	Vertical Systems	Pumping Well System	Extraction wells are used to capture and withdraw contaminated groundwater. This option is very versatile and can be used to contain contaminant migration. Long-term maintenance is required.	Retained
		Well Point System	Groundwater is removed from the subsurface through closely spaced well points connected by a main suction header. Effective only for shallow depths and lift of less than 22 feet. Depth of contamination at the Evergreen Manor site is greater than 22 feet.	Eliminated
	Horizontal Systems	Trench Collection System	Subsurface trenches are used to intercept contaminated groundwater. This option can eliminate or reduce the number of wells needed for groundwater extraction. Long-term maintenance is required. Depth of contamination is outside technology scope and geology is not suited for this application.	Eliminated
		Horizontal Well System	Uses proven drilling techniques to drill horizontal wells. This option does not disturb the site as much as trenching. Due to depth of contamination, this technology is not appropriate.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
Treatment	*In situ*: Physical/Chemical Processes	Geochemical Fixation	Involves inducing chemicals into an aquifer that causes fixation of contaminants onto aquifer material. No change in chemical toxicity. However, geochemical conditions could return to original state at some time in future causing remobilization of contaminants. Effective highly dependant upon subsurface properties. Mostly applicable to metal and radionuclide waste. Not applicable for VOCs.	Eliminated
		Chemical Injection	Chemically enhanced solubilization using surfactants for retrieval of nonaqueous phase liquids (NAPLs). Increases the effective solubility of organic contaminants by two or three orders of magnitude. TCE detected at the site has not exceeded solubility limits and therefore does not exist in concentrated NAPL form in groundwater.	Eliminated
		Permeable Reactive Barrier- Iron-based Reactor Material	A metal (usually iron) is placed in the subsurface to intercept contaminated groundwater. The metal enhances abiotic degradation of halogenated organic compounds. Passive treatment. Can operate over a wide range of environmental conditions. The reactor material has a long operational life. Biofouling and hydrogeology may be problematic, but can be mitigated.	Retained
		Permeable Reactive Barrier-Carbon-based Reactor Material	Applicable to nonpolar organic compounds only. Will not remove polar organics. The likelihood of short bed-life makes the use of carbon impractical. Typically only effective for relatively shallow zones. Not effective for site contaminants (TCE).	Eliminated
		Permeable Reactive Barrier - Limestone	Crushed limestone is used to neutralize acidic groundwater. It is pH-dependant and site specific. Not effective for VOCs.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
		Hydrolysis	Hydrolysis is the use of water to destroy, decompose, or alter an organic contaminant to render it less toxic. This technology is applicable to organics only. It is rarely used for *in situ* applications. It is difficult to apply and sensitive process controls are required. It is difficult to predict by-product formation.	Eliminated
		Oxidation	Organic compounds can be degraded *in* situ by reactions with oxidants like ozone or peroxides. In *situ* application is limited in application because it is difficult to monitor and to control by-product formation. It is applicable to organics only.	Retained
		Reductive Dechlorination (HRC)	Organic compounds can be degraded *in situ* by reactions with an ester (i.e, HRC). A polylactate ester is specially formulated for the slow release of lactic acid upon hydration. The lactic acid is converted to several other acids and produces hydrogen along the way. The hydrogen produced by this process is used by reductive dechlorinators which are capable of dechlorinating the chlorinated VOCs.	Retained
		Air Sparging	Process involves forcing air into aquifer causing volatilization of VOCs. The organic vapors are then extracted from the vadose zone using soil vapor extraction. Site geology is suited for this process. Effective treatment for TCE.	Retained
		Directional Wells	This process is used to enhance other *in situ* treatment options. Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling. More expensive than conventional wells. Since impacted groundwater is readily accessible using vertical wells, this process option is not appropriate.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
		Dual Phase Extraction	A high vacuum system is applied to simultaneously to remove groundwater and vapors from low permeability or heterogeneous formations. The extracted vapors and groundwater need to be separated and treated. Site geology indicates highly variable permeability; therefore, site geology will not facilitate this process option.	Eliminated
		Free Product Recovery	Undissolved liquid-phase organics are removed from subsurface formations. During the investigations conducted, undissolved liquid-phase organics were not detected in groundwater.	Eliminated
		Hot Water and Steam Flushing	Steam (or hot water) is forced into an aquifer through injection wells to vaporize VOCs. Combined with vacuum extraction, more applicable to SVOCs and fuels because more cost-effective processes are available for VOCs.	Eliminated
		Hydrofracturing	Pressurized water is injected to increase the permeability of consolidated material or relatively impermeable unconsolidated material. Based on site geology, the permeability of subsurface material is medium to high.	Eliminated
		Vacuum Vapor Extraction	Air is injected into a well, lifting contaminated groundwater in the well and transferring VOCs in water to air bubbles. Air bubbles are then collected by vacuum extraction. Also called "in well air stripping." This technology is considered to be experimental. Due to the depth of contamination in groundwater, VOCs may re-dissolve from air bubbles into the water column before extraction is complete.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
	In situ: Bioremediation	Co-metabolic Processes	An emerging application involves the injection of water containing dissolved methane and oxygen into groundwater to enhance methanotrophic biological degradation. This class of micro-organisms can degrade chlorinated organics.	Retained
		Nitrate Enhancement	This process enhances the anaerobic biodegradation through the addition of nitrate. Not effective for chlorinated organics.	Eliminated
		Oxygen Enhancement with Air Sparging	Air is injected under pressure below water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of organic contaminants by naturally occurring microbes. Effective primarily for degradation of non halogenated VOCs and SVOCs.	Eliminated
		Oxygen Enhancement with Hydrogen Peroxide	Oxygen enhancement with hydrogen peroxide is primarily used to biologically degrade non-halogenated VOCs.	Eliminated
	Ex Situ: Chemical/Physical Processes	Air Stipping	Air stripping removes organics from groundwater by forcing high-pressure air through liquid. Contaminants are transferred from the liquid phase to gaseous phase and then vented. This process option is for the treatment of VOCs. An emission control device may be required.	Retained
		Steam Stripping	This process is more energy intensive than the simple air stripping process option. It is therefore more effective at recovering wastes with high concentrations of volatile and wastes with low volatility when compared to air stripping. Since VOCs in groundwater at the Evergreen Manor site are highly volatile, conventional air stripping should be effective.	Eliminated
		Cascade Aerator	Originally used as an effective means of oxygenating large flows of wastewater; this process option is also used for the removal of VOCs from groundwater.	Retained

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
		UV Oxidation	This technology is primarily used for organics only, particularly chlorinated hydrocarbons. Pretreatment may be needed to lower turbidity. Some VOCs may volatilize rather than being destroyed, requiring potential emission controls.	Retained
		Chemical Oxidation/Reduction	This process option is primarily for aldehydes, mercaptans, phenols, benzidine, unsaturated acids and certain pesticides. In some cases, undesirable by-products may be formed as a result of oxidation/reduction.	Eliminated
		Liquid Phase Carbon Adsorption	This technology is primarily used for removal of organics. Soluble molecules from a solution are bonded onto a carbon surface. The carbon material is replaced and the saturated carbon is regenerated or incinerated. It is easily implemented.	Retained
		Resin Adsorption	This process option is used for the removal of organic contaminants not amenable to treatment by other processes. The resin, however, must be customized for specific contaminants of concern. Polymeric adsorbents require pretreatment of feed streams to remove suspended solids, oils and greases, and to control pH and temperatures. The resin must be disposed of once saturated; it cannot be regenerated.	Eliminated
		Membrane Microfiltration (with or without Precipitation)	This technology does not treat VOCs. It removes suspended solids such as heavy metals, cyanide, uranium and organic particles from liquids. The resulting residuals ("cake") may require additional treatment prior to disposal.	Eliminated
		Ion Exchange	This process option is for the removal of metals only. Extensive pretreatment may be required prior to ion exchange. Suspended solids must be removed to prevent fouling and plugging of the resin bed.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
		Reverse Osmosis	This process can reduce concentrations of dissolved organic and inorganic solids in groundwater, but extensive pretreatment is often required, and the equipment is subject to fouling and plugging of the resin bed.	Eliminated
		Dechlorination	Dechlorination is primarily used for PCBs and dioxins including transformer liquids.	Eliminated
		Liquid Injection Incinerator	This technology is mostly used for hazardous waste streams containing high concentrations of organics. Non-oxidizable inorganics are not treated. It is for combustible liquids with little or no water content. Concentrations of organic contaminants are too low for this high energy process.	Eliminated
	Ex Situ Biological Processes	Bioreactors	Bioreactors degrade contaminants in water with microorganisms through attached or suspended biological systems. Requires close monitoring and process control. Treatment and disposal of sludges required. Primarily used to treat VOCs and fuel hydrocarbons. This is a long-term technology and may take up to several years.	Eliminated
	On-Site Pretreatment/ Post-Treatment	Precipitation	May be used as pretreatment to other technologies. Influent metals concentration may require pretreatment for some process options; post-treatment for metals may be needed to meet discharge criteria. Metals are not COCs at the site.	Eliminated
		Filtration	May be used to remove suspended solids or precipitated metals. Metals are not COCs at the site but may require attention to minimize equipment maintenance for other process options.	Retained

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
Monitored Natural Attenuation	Monitored Natural Attenuation	Monitored Natural Attenuation	Natural subsurface processes are allowed to reduce contaminant concentrations to acceptable levels. Needs case-by-case approval from EPA. Extensive site characterization is needed.	Retained
Disposal	On-site Disposal: (Untreated Groundwater)	Deep Well Injection	[illegible] groundwater could be injected under RCRA regulations; however, a [illegible] aquifer system underlies the site.	Eliminated
	On-site Disposal: (Treated Groundwater)	Shallow Well Injection	[illegible] well injection consists of wells completed in the upper portion of the [illegible] for the injection of treated groundwater. Injection wells are difficult to [illegible] because they are subject to biofouling and scaling. In addition, because of the large extent of plume, multiple injection points may be needed. The space available for installing wells is limited due the proximity of residences.	Eliminated
		Infiltration Gallery	An infiltration gallery consists of a trench designed to recharge the surficial aquifer. This process option will allow recharge of the upper portion of the aquifer.	Retained
		Subsurface Irrigation	A subsurface irrigation system for the disposal of treated groundwater is designed and operated much like a conventional wastewater leachfield. Long lengths of perforated pipes are installed beneath the ground surface in closely [illegible] shallow trenches. The perforated pipes have a tendency toward fouling [illegible]. It would be difficult to [illegible] a high volume system efficiently [illegible]. Space limitations associated with treatment system siting may [illegible] disposal location or eliminate this option from consideration.	Eliminated

Table 2-3

Identification and Screening of Technologies for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Technical Implementability	Screening Results
		Surface Irrigation	A surface irrigation system consists of a network of evenly spaced, high-volume spray guns spaced evenly to distribute treated groundwater over a system efficiently operational. It may promote infiltration of additional contaminants from soil to groundwater. Space limitations associated with treatment system siting may require distant disposal location or eliminate this option from consideration.	Eliminated
	Off Site Disposal: (Treated Groundwater)	Off-Site Facility	Groundwater is containerized and shipped to approved facility. Volume of groundwater requiring disposal may be large. Pretreatment may be required.	Retained
		NPDES-Permitted Outfall	Would require compliance with requirements of a NPDES permit would be followed prior to discharge to Dry Creek or Rock River.	Retained
		POTW	Treated water discharged to sanitary sewer. Would require compliance with requirements of POTW and/or discharge permit. There are no POTWs in the vicinity of the Evergreen Manor site.	Eliminated
Disposal of Treatment Residuals	Off Site Disposal	Landfill	Residuals may contain metals. May require pretreatment of residuals. Hazardous waste handling and disposal may be required.	Retained

Shading indicates the technology process option was eliminated from further consideration.

Table 2-4

Process Options Retained for Further Analysis Based on Technical Implementability Evergreen Manor Site Roscoe, Illinois

Media	General Response Action	Remedial Technology Type	Retained Process Option
Groundwater	No Action	No Additional Action	No Action
	Institutional Controls	Monitoring	Long-term Groundwater Monitoring
		Groundwater Use Restrictions	Groundwater Use Restrictions
		Access Restrictions	Access Restrictions
	Collection	Vertical Systems	Pumping Well System
	Treatment	*In-situ*: Physical/Chemical Processes	Permeable Reactive Barrier - Iron-based Reactor Material
			Oxidation
			Reductive Dechlorination (HRC)
			Air Sparging
		In situ: Bioremediation	Co-metabolic Processes
		Ex Situ: Physical/Chemical Processes	Air Stripping
			Cascade Aerator
			UV Oxidation
			Liquid Phase Carbon Adsorption
		On-Site Pretreatment/ Post-Treatment	Filtration
	Monitored Natural Attenuation	Monitored Natural Attenuation	Monitored Natural Attenuation
	Disposal	On-site Disposal (Treated Groundwater)	Infiltration Gallery

Table 2-4

Process Options Retained for Further Analysis Based on Technical Implementability Evergreen Manor Site Roscoe, Illinois (Continued)

Media	General Response Action	Remedial Technology Type	Retained Process Option
Groundwater	Disposal	Off-site Disposal (Treated Groundwater)	Off-site Facility
			NPDES-Permitted Outfall
	Disposal of Treatment Residuals	Off-site Disposal	Landfill

Table 2-5

Evaluation of Process Options for Groundwater
Evergreen Manor Site
Roscoe, Illinois

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
No Action	No Additional Action	No Action	Will not result in the attainment of the remedial action objectives (RAOs) in the foreseeable future.	Consideration required by National Contingency Plan. Easily implementable.	No Cost	Retained
Institutional Controls	Monitoring	Long-term Groundwater Monitoring	Will not attain RAOs in near future. Can be used to monitor the effectiveness or completion of treatment.	Can be readily implemented.	Low	Retained
	Groundwater Use Restrictions	Groundwater Use Restrictions	Restricts use of contaminated Groundwater and thereby limits future exposure of receptors to site contaminants. Does not reduce toxicity, mobility or volume of contaminants.	Can be implemented	Low	Retained
	Access Restrictions	Access Restrictions	Limits future exposure of human receptors to site contaminants. Does not reduce toxicity, mobility, or volume of contaminants.	Can be implemented.	Low	Retained
Collection	Vertical Systems	Pumping Well System	Effective capture zones can be created to intercept and extract groundwater for treatment. Reduces mobility of contamination in groundwater by stabilizing the plume, but does not reduce toxicity or volume of contaminants.	Readily implementable using conventional techniques. Long-term maintenance is required.	Medium	Retained
Treatment	*In situ*: Physical/ Chemical Processes	Permeable Reactive Barrier - Iron-based Reactor Material	Effective technology for removal of chlorinated VOCs from water. Effective in reducing toxicity and volume of contamination.	Can be implemented. Long-term maintenance may be needed to maintain permeability. May require replenishment of iron prior to remedy completion.	High	Retained

Table 2-5

Evaluation of Process Options for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
		Oxidation	Not as effective [illegible] high order chlorinated VOCs (i.e., [illegible] reductive dechlorination	Difficult to implement based on the size of the plume. Site conditions may require application at closely spaced intervals.	High	Eliminated
		Reductive Dechlorination using Hydrogen	Effective technology for removal of chlorinated VOCs from water. Effective in reducing toxicity and volume of contamination. Does not reduce mobility of contaminants.	Difficult to implement based on size of plume. Would need application on a 20-foot grid spacing. May require repeat application if expendable material is exhausted prior to remedy completion.	High	Eliminated
		Air Sparging	Effective in removing volatile organics in water.	Relatively difficult to implement at the site. Location of vapor recovery would be difficult due to depth and size of plume. Due to the depth of contamination, the [illegible] may re-dissolve before extraction.	Medium	Eliminated
	In-Situ Bioremediation	Cometabolic Processes	Effectiveness [illegible] depends on methanotrophic microbial population in subsurface.	Difficult to circulate the methane solution throughout every portion of the contaminated zone. Site conditions may make it difficult to maintain optimal conditions for biodegradation.	High	Eliminated

Table 2-5

Evaluation of Process Options for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
	Ex Situ: Physical/ Chemical Processes	Air Stripping	Effective technology for removal of VOCs from water. Reduces toxicity and volume of contaminants by removal from media.	Easily implementable technology. Many different designs of air strippers are sold preassembled. Requires long-term maintenance. Typically, high levels of iron and other constituents may lead to fouling, requiring frequent O&M. Off-gas will require treatment. However, groundwater conditions at the site will require minimal O&M and no off-gas treatment.	Medium	Retained
		Cascade Aeration	Modera[illegible] toxicity and volume [illegible] removal from media [illegible] will be able to meet [illegible] for discharge [illegible] treatment costs. [illegible] oxygen into water [illegible] from water. Air strippers [illegible] more effective in removal.	Easy to implement and maintain. Would require large enclosed structure under negative pressure to ensure all vapors are captured. Off-gas would require treatment.	Medium	Eliminated

Table 2-5

Evaluation of Process Options for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	On Site: Pretreatment/ Post-Treatment	Filtration	Reduces toxicity and volume of contaminants by removal from media. Although process does not address chlorinated VOCs, may be required to attain discharge requirements.	Relatively easy to implement. Requires regular O&M. Filters require regular changeout and disposal.	Low	Retained

Table 2-5

Evaluation of Process Options for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
Monitored Natural Attenuation	Monitored Natural Attenuation	Monitored Natural Attenuation	Reduces toxicity and volume of contamination over time. May require several years or decades to attain RAOs, if at all. However, the overall decrease of the contaminated plume, favorable site conditions, contaminants amenable to natural attenuation substantiated by overall decrease in concentrations, presence of PCE upgradient possibly breaking down to TCE downgradient, and presence of numerous daughter products at low levels throughout the plume and other site-specific data , appears to indicate that monitored natural attenuation would be effective for at the Evergreen Manor site.	Relatively easy to implement given the existing site conditions.	Low	Retained
Disposal	On-site Disposal (Treated Groundwater)	Infiltration Gallery	Effective [illegible] treated groundwater. Does [illegible] mobility or volume of contam[illegible]	Readily implementable. Requires preparation of the disposal trench. May become backed up during periods of high water table.	Low	Eliminated
	Off-site Disposal (Treated Groundwater)	Off-site Facility	Effect[illegible] treated water.	Groundwater is containerized and transported to an approved facility. Due to the volume of water that will be generated, this option is not practical.	Medium	Eliminated

Table 2-5

Evaluation of Process Options for Groundwater
Evergreen Manor Site
Roscoe, Illinois
(Continued)

General Response Action	Remedial Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Screening Results
		NPDES-Permitted Outfall	Effective for discharge of treated water.	Easily implementable. The Dry Creek and Rock River are located near the site. Pemitting may be required.	Low	Retained
	Off-site Disposal	Landfill	Effective for disposal of treatment residuals.	Land ban restriction may apply to some constituents. May require pretreatment of residuals.	Medium	Retained

Shading indicates the technology process option was eliminated from further consideration.

Table 2-6

Process Options Retained for Further Analysis for Groundwater Based on Effectiveness, Implementability and Cost Evergreen Manor Site Roscoe, Illinois

Media	General Response Action	Remedial Technology Type	Retained Process Option
Groundwater	No Action	No Additional Action	No Action
	Institutional Controls	Monitoring	Long-term Groundwater Monitoring
		Groundwater Use Restrictions	Groundwater Use Restrictions
		Access Restrictions	Access Restrictions
	Collection	Vertical Systems	Pumping Well System
	Treatment	*In Situ:* Physical/Chemical Processes	Permeable Reactive Barrier - Iron-based Reactor Material
		Ex Situ: Physical/Chemical Processes	Air Stripping
		On Site: Pretreatment/ Post-Treatment	Filtration
	Monitored Natural Attenuation	Monitored Natural Attenuation	Monitored Natural Attenuation
	Disposal	Off-Site Disposal (Treated Groundwater)	NPDES-Permitted Outfall
	Disposal of Treatment Residuals	Off-site Disposal	Landfill

Table 3-1

Preliminary Screening of Remedial Alternatives
Evergreen Manor Site
Roscoe, Illinois

Alternative	Effectiveness	Implementability	Total Remedial Cost	Screening Result
1	This alternative would not be effective in protecting human health and the environment or reducing the toxicity, mobility, or volume of the COCs. It would be unknown whether the RAOs would be attained or not.	Readily implementable.	None	Retained
2	The extraction and treatment of the groundwater would effectively treat the contaminant plume. The possibility of residual contamination existing below the site would increase the time required to achieve cleanup objectives and ultimately meet RAOs. Given the protectiveness of human health and the environment, the overall effectiveness of this alternative would be high.	Institutional controls including groundwater monitoring and groundwater restrictions and the air monitoring program would be easy to implement. Based on known site geology, the installation of extraction wells would be easy to implement. The pump-and-treat system would be easy to construct. However, operation and maintenance of the equipment will be required. Land acquisition for the treatment buildings and associated piping may be difficult to obtain. Discharge of stripper emissions and treated water may require permitting, which could be relatively easy to arrange. If additional remedial actions are needed to treat the environmental media at the site, future remedial actions could be easily implemented. The discharge permit, if needed, would be relatively easy to obtain and would set the effluent requirements for the treatment system. Verification samples of the treated groundwater would ensure that permit requirements are met.	High	Retained

Table 3-1

Preliminary Screening of Remedial Alternatives
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Alternative	Effectiveness	Implementability	Total Remedial Cost	Screening Result
3	Monitored natural attenuation will reduce levels to below MCLs. The toxicity of TCE and PCE will be reduced by natural attenuation. Monitored natural attenuation is an effective long-term response action. Given the protectiveness of human health and the environment, the overall effectiveness of this alternative would be high.	Long-term groundwater monitoring is easily implementable. Institutional controls including groundwater monitoring and groundwater restrictions and the air monitoring program would be easy to implement. Based on known site geology, the installation of extraction wells would be easy to implement. If additional remedial actions are needed to treat the environmental media at the site, future remedial actions could be easily implemented. Detailed contaminant fate and transport modeling would be needed to monitor the effectiveness of natural attenuation. The U.S. EPA approves monitored natural attenuation as a final remedy only after detailed evaluation of the site-specific data is conducted. Based on data evaluation conducted to date, it appears that this alternative would be relatively easy to implement.	Moderate	Retained

Table 3-1

Preliminary Screening of Remedial Alternatives
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Alternative	Effectiveness	Implementability	Total Remedial Cost	Screening Result
4	The treatment of the groundwater plume with a zero-valent iron PRB would effectively dechlorinate the COCs identified within the groundwater. Adverse chemical reactions or byproducts may occur when reacting with constituents in the contaminant plume. The aerobic nature of the groundwater can be potentially detrimental to this technology. Water could breach the barrier and can flow around or underneath the iron wall if not designed properly for the site or if the PRB becomes fouled. It would be necessary to keep the reactive-zone permeability equal to or greater than the permeability of the aquifer to avoid diversion of the flowing waters around the funnel-and-gate system. Based on the protectiveness of the human health and environment and serious complications that may result if fouling of the PRB occurs, the overall effectiveness of this alternative in achieving the RAOs would be moderate.	The containment wall used to funnel the groundwater to the PRB would be constructed using slurry columns to a depth of approximately 80 ft. Due to the significant depth of contamination, conventional excavation techniques would not be appropriate for this site. Therefore, the funnel walls would be installed using slurry columns via deep soil mixing. Soil mixing does not require excavation, dewatering, or shoring. Additionally, only a minimal amount of spoils would be brought to the surface during deep soil mixing. Therefore, only a minimal quantity of soil would require off-site disposal. Discontinuities may occur in the reactive barrier causing part of the flow to merge untreated through the reactive barrier. The PRB should operate for years with minimal, if any, maintenance; however, periodic replacement of rejuvenation of the reaction medium might be required after its capacity is exhausted or it is clogged by precipitants and/or microorganisms. Due to space limitation along the northern bank of the Rock River, land acquisition or easements would be difficult to obtain, and movement of materials and equipment would also be onerous. Overall, the PRB system would be difficult to implement.	High	Eliminated

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARARs				
Clean Water Act (33 USC Sect. 1251-1376)				
Water Quality Criteria (40 CFR Part 131 Quality Criteria for Water, 1976, 1980, 1986)	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	No	Yes	Yes
Safe Drinking Water Act (40 USC Sect. 300)				
National Primary Drinking Water Standards (40 CFR Part 141)	Establishes health-based standards for public water systems (maximum-contaminant levels).	No	Yes	Yes
National Secondary Drinking Water Standards (40 CFR Part 143)	Establishes welfare-based standards for public water systems (secondary maximum contaminant levels).	No	Yes	Yes
Maximum Contaminant Level Goals (40 CFR 141.50, 141.51, 141.52)	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	No	Yes	Yes
Resource Conservation and Recovery Act (as amended by HSWA) (40 USC 6901)				
Groundwater Monitoring and Response Requirements (40 CFR 264.94)	Standards for 14 toxic compounds to be monitored in the groundwater at RCRA facilities.	No	Yes	Yes

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
POTENTIAL FEDERAL LOCATION-SPECIFIC ARARs				
Endangered Species Act of 1973 (16 USC 1531 et seq.)	Establishes requirements to protect species threatened by extinction and habitats critical to their survival.	NA	NA	NA
National Historic Preservation Act of 1966 (UST 470 et seq.)	Establishes requirements to protect historically significant facilities.	NA	NA	NA
Executive Order 11988, Floodplain Management (40 CFR Part 6, Appendix A)	Establishes agency policy and guidance for carrying out the provisions of Executive Order 11988 "Floodplain Management."	NA	NA	NA
Executive Order 11990, Protection of Wetlands (40 CFR Part 6, Appendix A)	Requires minimization of destruction, loss, or degradation of wetlands.	NA	NA	NA
Clean Water Act Section 404 (40 CFR Parts 230,231)	Action to prohibit discharge of dredged or fill material into a wetland without permission.	NA	NA	NA
Fish and Wildlife Coordination Act (16 USC 661-666 40 CFR 6.302 [g])	Requires consultation when a federal department or agency proposes or authorizes any modification of any stream or other water body; requires adequate provisions for protection of fish and wildlife resources. It also establishes policy for Executive Order 11990, "Protection of Wetlands."	NA	NA	NA

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Discharges of Dredged or Fill Material into Waters of the United States (33 CFR Part 323)	Established permit requirements for actions that involve dredging or filling in of a navigable waterway or wetland.	NA	NA	NA
To Be Considered (TBC) Standards				
The Native American Grave Protection and Repatriation Act (NAGPRA). Public Law 101-601 (Nov. 16, 1990)	Law provides for protection of Native American graves, and for other related purposes.	NA	NA	NA
The Migratory Bird Treaty Act (16 USC 703)	Law makes it unlawful to take, kill, or possess any migratory bird, any part, nest, or eggs of any such bird.	NA	NA	NA
The Archeological Resources Protection Act of 1979. Public Law 96-95	Provides for the protection of archeological resources on federal and Indian lands.	NA	NA	NA
POTENTIAL FEDERAL ACTION-SPECIFIC ARARs				
Occupational Safety and Health Administration (OSHA) Regulations (29 USC 651)				
29 CFR 1910.120	Establishes limits for worker exposures during response actions at CERCLA sites.	NA	Yes	Yes
29 CFR Part 1926	Establishes construction standards.	NA	Yes	Yes

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Army Corp of Engineers Program				
Discharges of Dredged or Fill Materials into Waters of the United States (33 CFR Part 323)	Establishes requirements for actions that involve dredging or filling in of a navigable waterway or wetland.	NA	NA	NA
Clean Air Act				
National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50)	Establishes standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead).	No	Yes	Yes
Section 101	Calls for development and implementation of regional air pollution control programs.	NA	NA	NA
U.S. EPA Regulations on Approval and Promulgation of Implementation Plans				
40 CFR Part 52	Requires the filing of a notice with the state regarding intent to install a new stationary source of air pollution.	NA	NA	Yes
U.S. EPA Regulation on National Emission Standards for Hazardous Air Pollutants				
40 CFR Part 61	Regulates emissions of hazardous air pollutants.	NA	NA	Yes
Federal Water Pollution Control Act as Amended by the Clean Water Act of 1977				
Section 208(b)	The proposed action must be consistent with regional water quality management plans as developed under Section 208 of the Clean Water Act.	No	Yes	Yes

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
U.S. EPA National Pollutant Discharge Elimination System (NPDES) Permit Regulations				
40 CFR 122.21	Permit application must include a detailed description of the proposed action including a listing of all required environmental permits.	NA	Yes	NA
40 CFR 122.44	Federally approved state water quality standards. These may be in addition to or more stringent than federal water quality standards.	No	Yes	Yes
40 CFR 122.44(a)	Requires the use of the Best Available Technology (BAT) for toxic and non-conventional wastewaters or the Best Conventional Technology (BCT) for conventional pollutants.	No	Yes	No
40 CFR 122.44(e)	Discharge limits must be established for toxics to be discharged at concentrations exceeding levels achievable by the technology-based (BAT/BCT) standards.	No	Yes	Yes
40 CFR 122.44(l)	Requires monitoring of discharges to ensure compliance. Monitoring programs shall include data on the mass, volume, and frequency of all discharge events.	NA	Yes	NA
40 CFR 125.100	The site operator shall develop a best management practice (BMP) program and shall incorporate it into the operations plan or the NPDES permit application if required.	NA	Yes	NA

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Clean Water Act (33 USC Sect. 1251-1376)				
40 CFR Part 131	States are granted enforcement jurisdiction over direct discharges and may adopt reasonable standards to protect or enhance the uses and qualities of surface water bodies in the states.	NA	Yes	NA
U.S. EPA Regulations on Test Procedures for the Analysis of [Water] Pollutants				
40 CFR 136.1-136.4	These sections require adherence to sample preservation procedures including container materials and sample holding times.	NA	Yes	Yes
Resource Conservation and Recovery Act (RCRA) (42 USC 6901)				
40 CFR Part 261	Identifies those wastes subject to regulation as hazardous wastes.	NA	NA	NA
Transportation of Hazardous Waste (40 CFR Part 263)	Requires that transporters must be licensed hazardous waste haulers. In the event of a discharge during transportation, the transporter must take immediate action to protect human health and the environment and cleanup the discharge such that it no longer presents a hazard.	NA	Yes	NA
Releases from Solid Waste Management Units (SWMUs) (40 CFR 264.91 through 264.99)	These regulations establish groundwater protection standards and groundwater monitoring requirements for on-site SWMUs.	NA	NA	NA

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Containers (40 CFR 264.171 through 264.178)	Regulations cited under 40 CFR 264.171 to 264.178 (Subpart I) concern permanent on-site storage of hazardous wastes or temporary storage phases used during various cleanup actions such as removal or incineration.	NA	Yes	NA
Tanks (40 CFR 264.191 through 264.198)	Regulations under 40 CFR 264.191 to 264.198 (Subpart J) apply to tank storage of hazardous materials.	NA	Yes	NA
Miscellaneous Treatment Units (40 CFR Part 264 Subpart X)	Standards for environmental performance of miscellaneous treatment units.	NA	Yes	NA
Land Disposal Restrictions (LDRs) (40 CFR Part 268)	Requires any waste placed in land-disposal units to comply with LDRs by either attaining specific performance- or technology-based standards.	NA	NA	NA
U.S. Department of Transportation (DOT) Regulations				
40 CFR Parts 170 through 179	Establishes requirements for off-site transportation of site-generated waste	NA	Yes	NA
U.S. EPA Effluent Guidelines and Standards				
40 CFR 403.5	If wastes are discharged to a publicly owned treatment works facility (POTW) the treatment process must not allow waste to pass through untreated or result in contaminated sewage sludge.	NA	NA	NA

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
To Be Considered (TBCs) Standards				
OSWER Directive 9355.028	Control of air emissions from Superfund air strippers at Superfund groundwater sites.	NA	Yes	NA
POTENTIAL STATE CHEMICAL-SPECIFIC ARARs				
Illinois Permits and General Air Pollution Regulations (35 IAC Part 201))	Establishes requirements for permits necessary for construction or modification of any emission source and sets limits on discharge of air pollutants.	NA	Yes	NA
Illinois Emission Standards and Limitations for Stationary Sources (35 IAC Part 212)	Establishes emission standards for visible and particulate matter.	NA	NA	NA
Illinois Air Quality Standards (35 IAC Part 243)	Establishes air quality standards	NA	Yes	NA
Illinois Water Quality Standards (35 IAC Part 302)	Establishes general use water quality standards for protecting water for aquatic life, agricultural use, primary and secondary contact use, most industrial use, and ensuring the aesthetic quality of the aquatic environment.	No	Yes	Yes

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Monitoring and Reporting Requirements (35 IAC Part 305)	Prescribes requirements for monitoring, reporting, and measuring contaminant discharges.	No	Yes	Yes
Sewer Discharge Criteria (35 IAC Part 307)	Places certain restrictions on the types, concentrations and quantities of contaminants which can be discharged into the sewer systems and POTWs.	NA	NA	NA
Illinois Primary Drinking Water Standards (35 IAC Part 611)	Establishes health-based standards for public water systems.	NA	NA	NA
Illinois Groundwater Quality Standards (35 IAC Part 620)	Sets groundwater classification and associated water quality standards.	No	Yes	Yes
Identification and Listing of Hazardous Waste (35 IAC Part 721)	Defines those solid wastes which are subject to regulations as hazardous waste.	NA	NA	NA
Releases from Solid Waste Management Units (SWMUs) (35 IAC Part 724)	These regulations establish groundwater protection standards and groundwater monitoring requirements for on-site SWMUs.	NA	NA	NA
POTENTIAL STATE LOCATION-SPECIFIC ARARs				

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Procedures for Permit and Closure Plan Hearings (35 IAC Part 166)	Establish procedures for permits and closure plan hearings.	NA	NA	NA
To be Considered (TBC) Standards				
The Archeological and Paleontologist Resources Protection Act (20 ILCS 3435) and Human Skeletal Remains Protection Act (20 ILCS 3440)	Law related to human remains and artifacts that may be found in the conduct of any private or public construction project. These acts govern the assessment, handling, and disposition of remains and artifacts in Illinois.	NA	NA	NA
Illinois Historic Resources Protection Act (20 ILCS 3420 and 17 IAC 4180)	Law regarding historic preservation. It requires consultation with the State Historic Preservation Officer for projects that may impact historic resources.	NA	NA	NA
POTENTIAL STATE ACTION-SPECIFIC ARARs				
Illinos Permits and General Air Pollution Regulations (35 IAC Part 201)	Sets criteria for discharge of contaminants in the environment causing air pollution. Also establishes requirements for permits necessary for construction or modification of any emission source.	NA	Yes	NA
Illinois Emission Standards and Limitations for Stationary Sources (35 IAC Part 212)	Establishes emission standards for visible and particulate matter.	NA	NA	NA
Illinois Air Quality Standards (35 IAC Part 243)	Establishes air quality standards.	NA	Yes	NA

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
Illinois Water Quality Standards (35 IAC Part 302)	Establishes general use water quality standards for protecting water for aquatic life, agricultural use, primary and secondary contact use, most industrial use, and ensuring the aesthetic quality of the aquatic environment.	No	Yes	Yes
Illinois Effluent Standards (35 IAC Part 304)	Prescribes maximum concentrations of various contaminants that may be discharged to the waters of the state.	NA	Yes	NA
Monitoring and Reporting Requirements (35 IAC Part 305)	Prescribes requirements for monitoring, reporting, and measuring containment discharges.	NA	Yes	NA
Sewer Discharge Criteria (35 IAC Part 307))	Places certain restrictions on the types, concentrations and quantities of contaminants which can be discharged into the sewer systems and POTWs.	NA	NA	NA
Permits (35 IAC Part 309)	Establishes permit requirements for treatment, pretreatment, and discharge requiring NPDES permit.	NA	Yes	NA
Pretreatment Programs (35 IAC Part 310)	Establishes pretreatment standards for discharge to a POTW.	NA	NA	NA
Wastewater Treatment Plant Operator Certification (35 Part IAC 312)	Requires a certified operator for a wastewater treatment plant.	NA	Yes	NA
Illinois Primary Drinking Water Standards (35 IAC Part 611)	Establishes health-based standards for public water systems.	NA	NA	NA
Illinois Groundwater Quality Regulations (35 IAC Part 720)	Sets groundwater classification and associated water quality standards.	No	Yes	Yes

Table 4-1

Detailed Analysis of Alternatives
Compliance with Potential ARARs
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Potential ARARs	Requirements	Alternative 1	Alternative 2	Alternative 3
General Facility Standards (35 IAC Part 724, Subpart B)	Establishes minimum standards which define the acceptable management of hazardous waste.	NA	NA	NA
Standards Applicable to Tank Systems (35 IAC Part 724, Subpart J)	Establishes requirements for storing hazardous waste in tanks.	NA	Yes	NA
Standards Applicable to Special Waste Hauling (35 IAC Part 809)	Establishes requirements for hauling of special waste.	NA	NA	NA

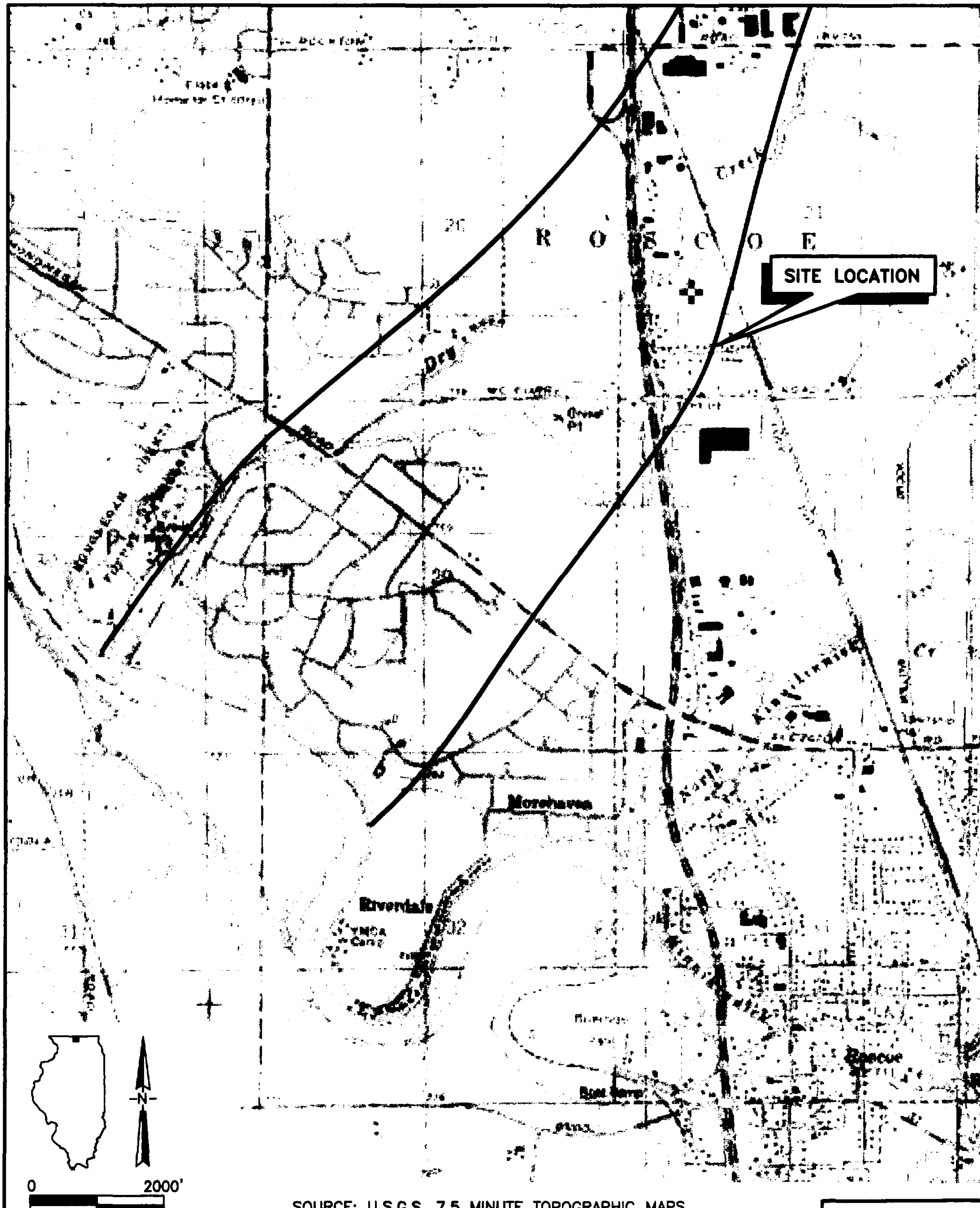
Table 4-2

Cost Summary of Remedial Alternatives
Evergreen Manor Site
Roscoe, Illinois

Alternative	Total Capital Cost ($)	Total O&M Present Worth ($)	Total Present Worth ($)
1	0	0	0
2	12,844,000	12,244,000	25,088,000
3	1,806,000	6,759,000	8,565,000

Notes:
Alternative 1: No Action.
Alternative 2: Institutional controls for air (vapor intrusion) and groundwater, extraction and treatment of contaminated groundwater, and off-site disposal of treated water.
Alternative 3: Institutional controls for air (vapor intrusion)and groundwater, and monitored natural attenuation (MNA) of contaminated groundwater.

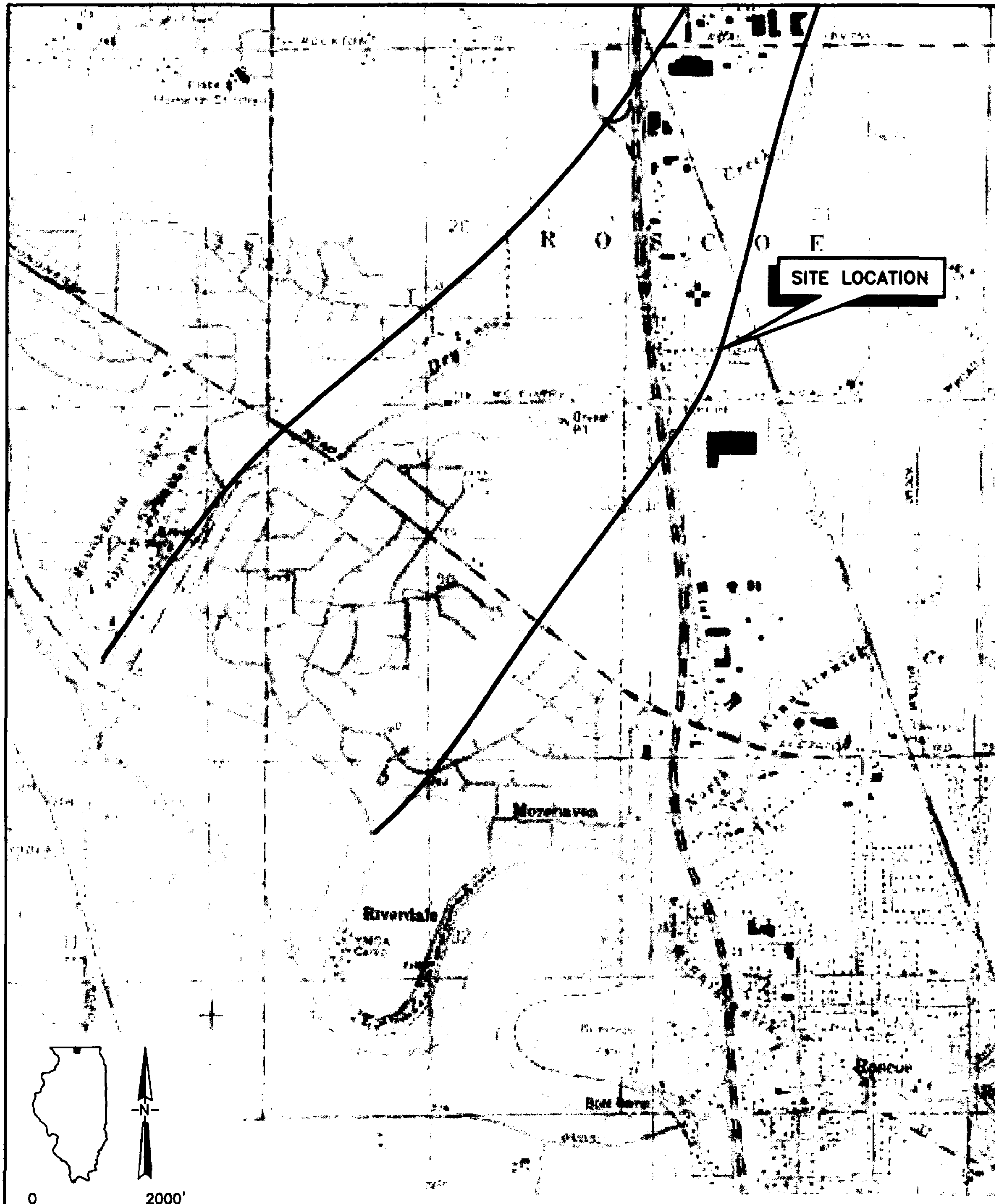
Figures



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC MAPS.
SOUTH BELOIT, ILLINOIS QUADRANGLE.

FIGURE 1-1

RESPONSE ACTION CONTRACT U.S. EPA CONTRACT No. 68-W7-0026 WORK ASSIGNMENT No. 139-RICO-05MZ DOCUMENT CONTROL No. RFW139-2A-ANPK	PROJECT LOCATION MAP EVERGREEN MANOR SITE Roscoe, Illinois



SOURCE: U.S.G.S. 7.5 MINUTE TOPOGRAPHIC MAPS.
SOUTH BELOIT, ILLINOIS QUADRANGLE.

FIGURE 1-1

RESPONSE ACTION CONTRACT

U.S. EPA CONTRACT No. 68-W7-0026
WORK ASSIGNMENT No. 139-RICO-05MZ
DOCUMENT CONTROL No. RFW139-2A-ANPK

PROJECT LOCATION MAP

EVERGREEN MANOR SITE

Roscoe, Illinois

LEGEND

- SURFACE WATER
- MUNICIPAL WELL
- GROUNDWATER SAMPLING LOCATION (IEPA MONITORING WELL)
- S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL
- STAFF GAUGE
- SURFACE WATER AND SEDIMENT SAMPLING LOCATION (APRIL 2002)
- APPROXIMATE SEDIMENT AND SURFACE WATER SAMPLING LOCATION (MAY 2000)
- MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)
- SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)
- EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED

NOTES:

1. CONSTITUENT EXCEEDS THE LOWEST SEDIMENT STANDARDS AS DEFINED BY U.S. EPA REGION IX PRELIMINARY REMEDIATION GOALS (PRGs) AND IEPA SOIL REMEDIATION FOR RESIDENTIAL USAGE.
2. CONSTITUENT EXCEEDS THE LOWEST SEDIMENT STANDARDS AS DEFINED BY U.S. EPA ECOTOX THRESHOLDS FOR SEDIMENT AND THE MOST CONSERVATIVE SEDIMENT CRITERIA LISTED IN THE COMPENDIUM OF ENVIRONMENTAL BENCHMARKS (ENVIRONMENT CANADA, 1990)
3. SEDIMENT RESULTS = ug/kg
   SURFACE WATER RESULTS = ug/L
4. PARCEL, ADDRESS INFORMATION, AND STREET DRAWINGS PROVIDED BY WINNEBAGO COUNTY, ILLINOIS.
5. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).

SOURCE:

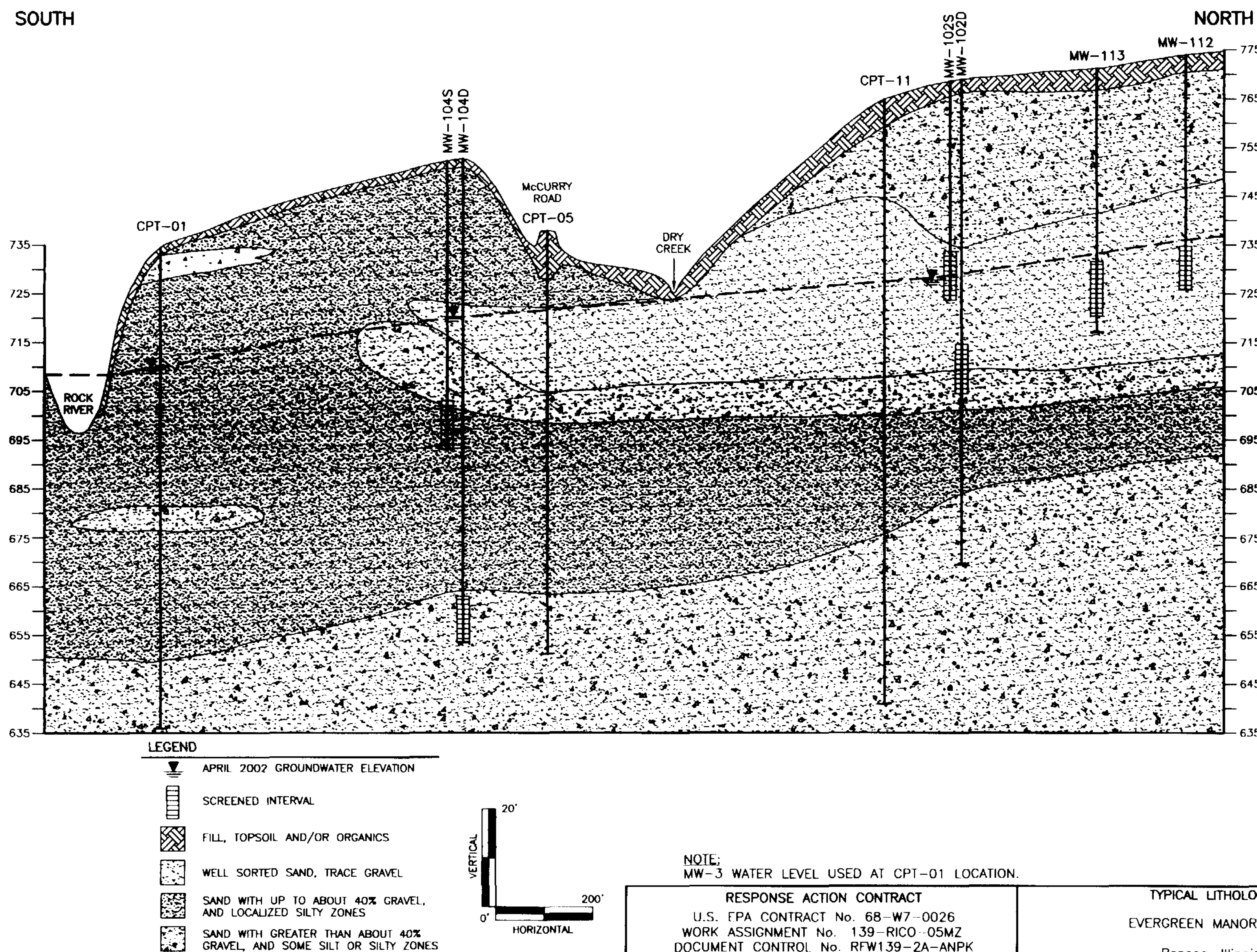
- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

N

0 200'
SCALE

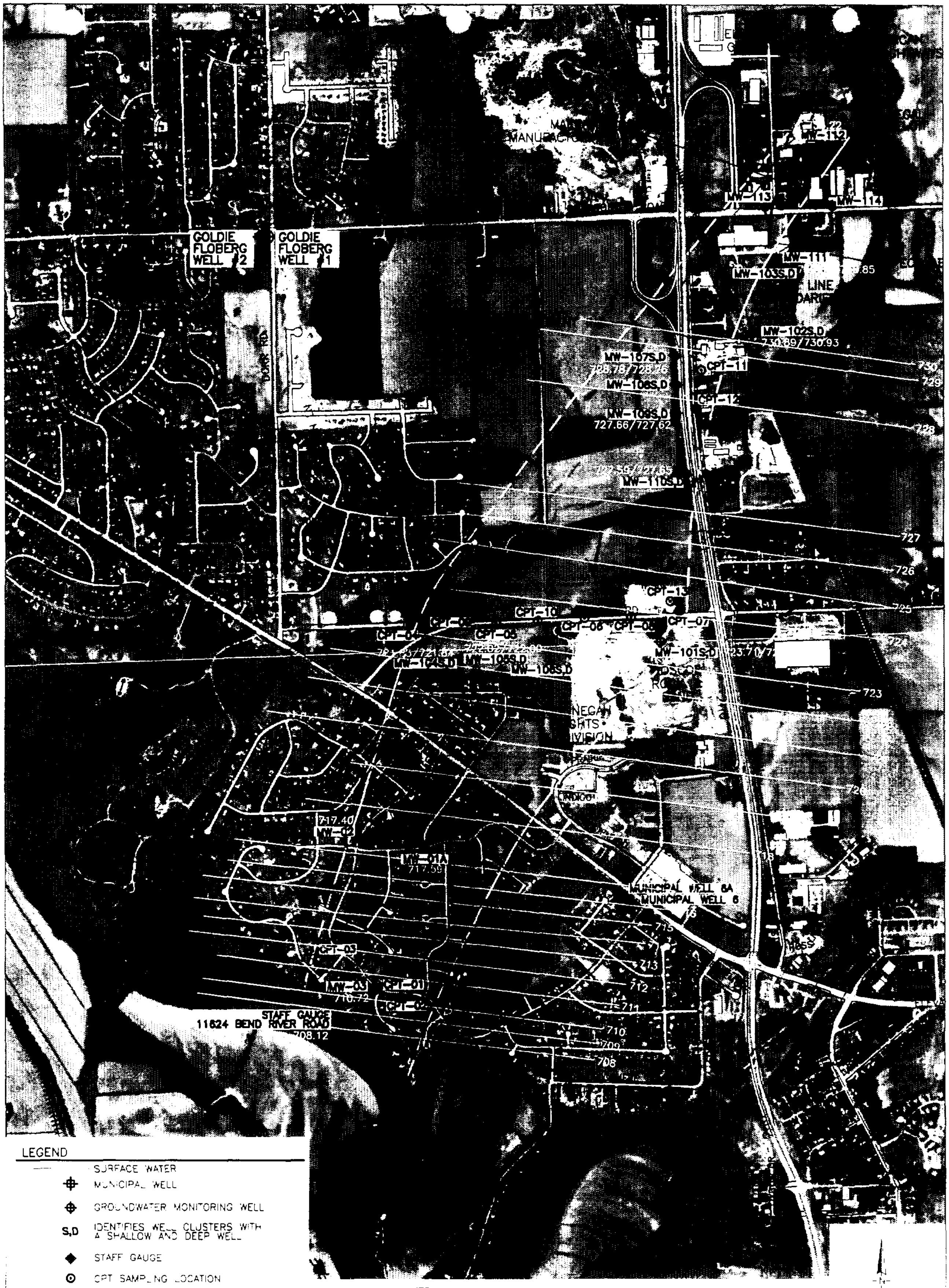
FIGURE 1-2

RESPONSE ACTION CONTRACT	SITE LAYOUT
U.S. EPA CONTRACT No. 68-W7-0026 WORK ASSIGNMENT No. 139-RICO-05MZ DOCUMENT CONTROL No. RFW139-2A-ANPK	EVERGREEN MANOR SITE Roscoe, Illinois



NOTE:
MW-3 WATER LEVEL USED AT CPT-01 LOCATION.

RESPONSE ACTION CONTRACT	TYPICAL LITHOLOGY	FIGURE 1-3
U.S. EPA CONTRACT No. 68-W7-0026 WORK ASSIGNMENT No. 139-RICO-05MZ DOCUMENT CONTROL No. RFW139-2A-ANPK	EVERGREEN MANOR SITE Roscoe, Illinois	



LEGEND

- SURFACE WATER
- MUNICIPAL WELL
- GROUNDWATER MONITORING WELL
- S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL
- STAFF GAUGE
- CPT SAMPLING LOCATION
- MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)
- SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)
- EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED

NOTES:

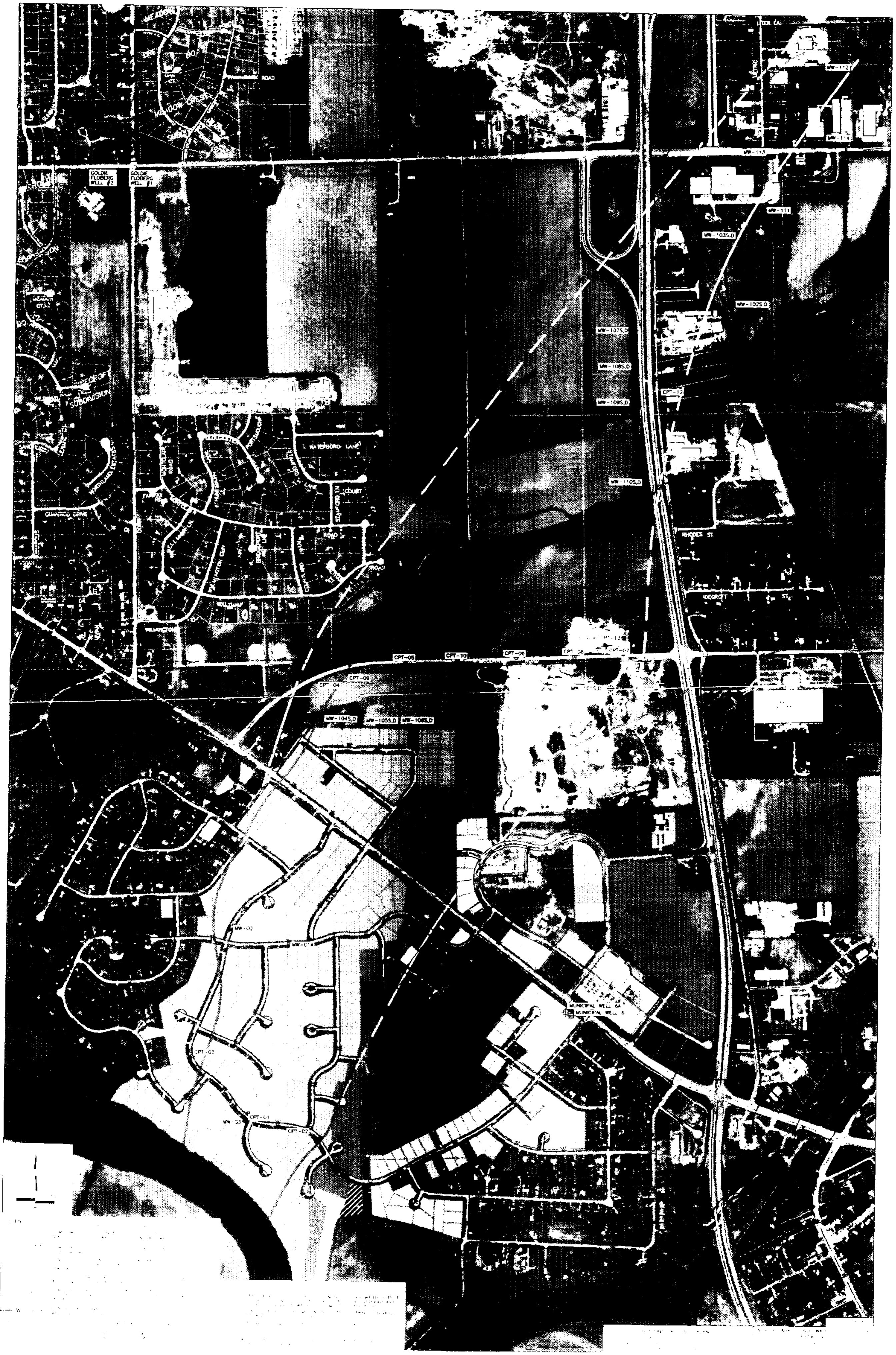
1. BASE MAP ADAPTED FROM CAD FILES PROVIDED BY WINNEBAGO COUNTY AND ORTHO (USGS, 1999).
2. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).

SOURCES:

- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

FIGURE 1-4

RESPONSE ACTION CONTRACT	POTENTIOMETRIC SURFACE MAP
U.S. EPA CONTRACT No. 68-W7-0026 WORK ASSIGNMENT No. 139-RICO-05MZ DOCUMENT CONTROL No. RFW139-2A-ANPK	EVERGREEN MANOR SITE Roscoe, Illinois


GOLDIE FLOBERG WELL #2
GOLDIE FLOBERG WELL #1
MEADOW CREST
WATERFORD LANE
QUANTICO DRIVE
RHODES ST
MW-113
MW-111
CPT-12
CPT-08
CPT-10
CPT-06
CPT-04
CPT-09
MW-02
CPT-01
CPT-02
MUNICIPAL WELL 6A
MUNICIPAL WELL 6

LEGEND

- SURFACE WATER
- MUNICIPAL WELL
- GROUNDWATER MONITORING WELL
- S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL
- CPT SAMPLING LOCATION
- MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)
- SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)
- EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED

NOTES:

1. BASE MAP ADAPTED FROM CAD FILES PROVIDED BY WINNEBAGO COUNTY AND ORTHO (USGS, 1999).
2. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).
3. THE ADDRESSES SHOWN ON THIS FIGURE MAY INCLUDE NON RESIDENTIAL (INDUSTRIAL) PROPERTIES.

SOURCES:

- POLK CITY DIRECTORIES – ROCKFORD AND BELVIDERE, IL (2002)
- PARTIAL LIST OF ADDRESSES PROVIDED BY WINNEBAGO COUNTY HEALTH DEPARTMENT.
- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

N

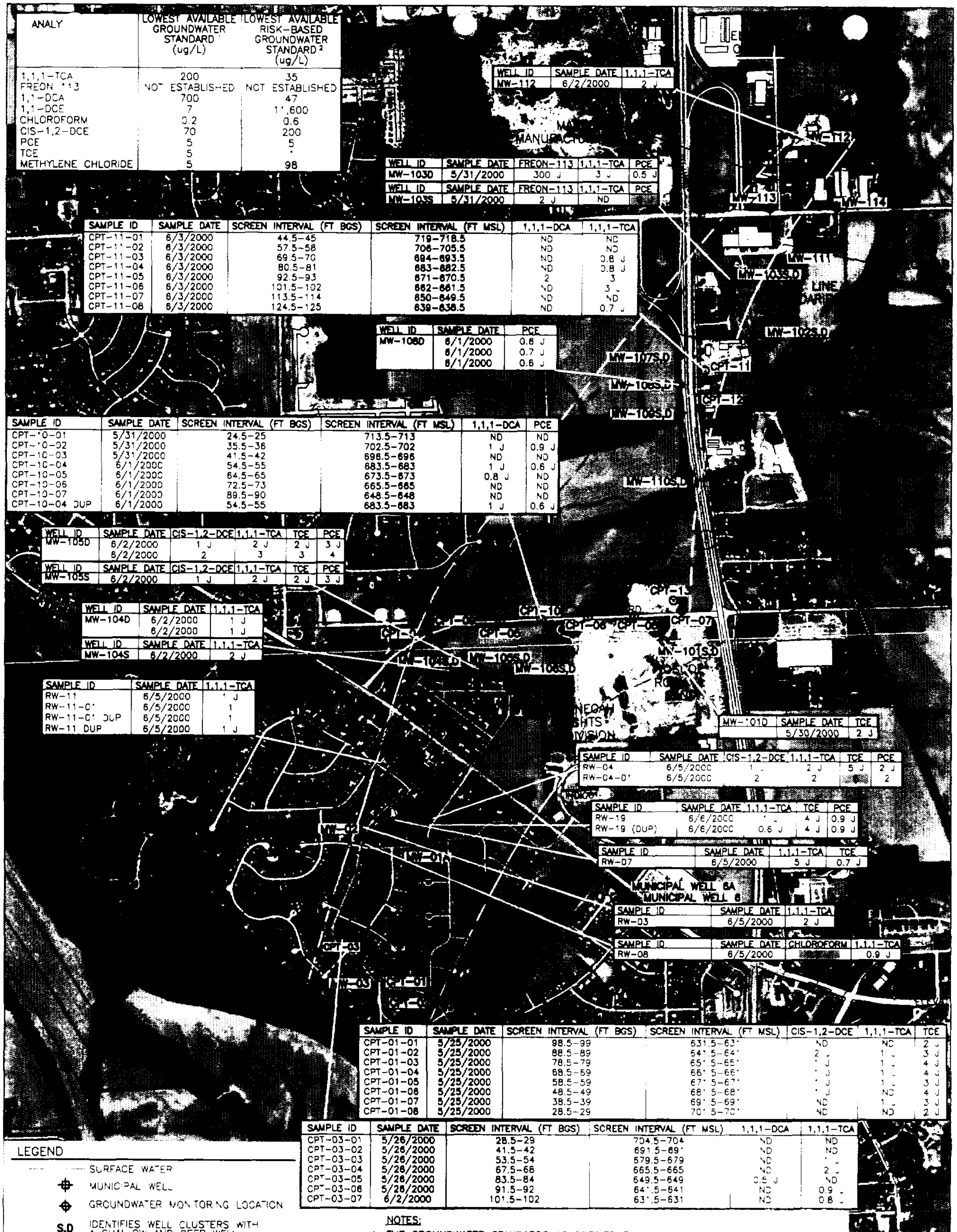
0 1200'

SCALE

FIGURE 1–6

RESPONSE ACTION CONTRACT
U.S. EPA CONTRACT No. 68–W7–0026
WORK ASSIGNMENT No. 139–RICO–05MZ
DOCUMENT CONTROL No. RFW139–2A–ANPK

POTENTIAL RESIDENCES NOT CONNECTED TO THE NPPWD
EVERGREEN MANOR SITE
Roscoe, Illinois



ANALY	LOWEST AVAILABLE GROUNDWATER STANDARD (ug/L)	LOWEST AVAILABLE RISK-BASED GROUNDWATER STANDARD 2 (ug/L)
1,1,1-TCA	200	35
FREON 113	NOT ESTABLISHED	NOT ESTABLISHED
1,1-DCA	700	47
1,1-DCE	7	11,600
CHLOROFORM	0.2	0.6
CIS-1,2-DCE	70	200
PCE	5	5
TCE	5	[illegible]
METHYLENE CHLORIDE	5	98

WELL ID	SAMPLE DATE	1,1,1-TCA
MW-112	6/2/2000	2 J

WELL ID	SAMPLE DATE	FREON-113	1,1,1-TCA	PCE
MW-103D	5/31/2000	300 J	3 J	0.5 J

WELL ID	SAMPLE DATE	FREON-113	1,1,1-TCA	PCE
MW-103S	5/31/2000	2 J	ND	[illegible]

SAMPLE ID	SAMPLE DATE	SCREEN INTERVAL (FT BGS)	SCREEN INTERVAL (FT MSL)	1,1,1-DCA	1,1,1-TCA
CPT-11-01	6/3/2000	44.5-45	719-718.5	ND	ND
CPT-11-02	6/3/2000	57.5-58	706-705.5	ND	ND
CPT-11-03	6/3/2000	69.5-70	694-693.5	ND	0.8 J
CPT-11-04	6/3/2000	80.5-81	683-682.5	ND	0.8 J
CPT-11-05	6/3/2000	92.5-93	671-670.5	2	3
CPT-11-06	6/3/2000	101.5-102	662-661.5	ND	3 J
CPT-11-07	6/3/2000	113.5-114	650-649.5	ND	ND
CPT-11-08	6/3/2000	124.5-125	639-638.5	ND	0.7 J

WELL ID	SAMPLE DATE	PCE
MW-106D	6/1/2000	0.6 J
	6/1/2000	0.7 J
	6/1/2000	0.6 J

SAMPLE ID	SAMPLE DATE	SCREEN INTERVAL (FT BGS)	SCREEN INTERVAL (FT MSL)	1,1,1-DCA	PCE
CPT-10-01	5/31/2000	24.5-25	713.5-713	ND	ND
CPT-10-02	5/31/2000	35.5-36	702.5-702	1 J	0.9 J
CPT-10-03	5/31/2000	41.5-42	696.5-696	ND	ND
CPT-10-04	6/1/2000	54.5-55	683.5-683	1 J	0.6 J
CPT-10-05	6/1/2000	64.5-65	673.5-673	0.8 J	ND
CPT-10-06	6/1/2000	72.5-73	665.5-665	ND	ND
CPT-10-07	6/1/2000	89.5-90	648.5-648	ND	ND
CPT-10-04 DUP	6/1/2000	54.5-55	683.5-683	1 J	0.6 J

WELL ID	SAMPLE DATE	CIS-1,2-DCE	1,1,1-TCA	TCE	PCE
MW-105D	6/2/2000	1 J	2 J	2 J	3 J
	6/2/2000	2	3	3	4

WELL ID	SAMPLE DATE	CIS-1,2-DCE	1,1,1-TCA	TCE	PCE
MW-105S	6/2/2000	1 J	2 J	2 J	3 J

WELL ID	SAMPLE DATE	1,1,1-TCA
MW-104D	6/2/2000	1 J
	6/2/2000	1 J

WELL ID	SAMPLE DATE	1,1,1-TCA
MW-104S	6/2/2000	2 J

SAMPLE ID	SAMPLE DATE	1,1,1-TCA
RW-11	6/5/2000	1 J
RW-11-01	6/5/2000	1
RW-11-01 DUP	6/5/2000	1
RW-11 DUP	6/5/2000	1 J

MW-101D	SAMPLE DATE	TCE
	5/30/2000	2 J

SAMPLE ID	SAMPLE DATE	CIS-1,2-DCE	1,1,1-TCA	TCE	PCE
RW-04	6/5/2000	1 J	2 J	5 J	2 J
RW-04-01	6/5/2000	2	2	[illegible]	2

SAMPLE ID	SAMPLE DATE	1,1,1-TCA	TCE	PCE
RW-19	6/6/2000	1 J	4 J	0.9 J
RW-19 (DUP)	6/6/2000	0.6 J	4 J	0.9 J

SAMPLE ID	SAMPLE DATE	1,1,1-TCA	TCE
RW-07	6/5/2000	5 J	0.7 J

SAMPLE ID	SAMPLE DATE	1,1,1-TCA
RW-03	6/5/2000	2 J

SAMPLE ID	SAMPLE DATE	CHLOROFORM	1,1,1-TCA
RW-08	6/5/2000	[illegible]	0.9 J

SAMPLE ID	SAMPLE DATE	SCREEN INTERVAL (FT BGS)	SCREEN INTERVAL (FT MSL)	CIS-1,2-DCE	1,1,1-TCA	TCE
CPT-01-01	5/25/2000	98.5-99	631.5-631	ND	ND	2 J
CPT-01-02	5/25/2000	88.5-89	641.5-641	2 J	1 J	3 J
CPT-01-03	5/25/2000	78.5-79	651.5-651	1 J	1 J	4 J
CPT-01-04	5/25/2000	68.5-69	661.5-661	1 J	1 J	4 J
CPT-01-05	5/25/2000	58.5-59	671.5-671	1 J	1 J	3 J
CPT-01-06	5/25/2000	48.5-49	681.5-681	1 J	ND	4 J
CPT-01-07	5/25/2000	38.5-39	691.5-691	ND	1 J	3 J
CPT-01-08	5/25/2000	28.5-29	701.5-701	ND	ND	2 J

SAMPLE ID	SAMPLE DATE	SCREEN INTERVAL (FT BGS)	SCREEN INTERVAL (FT MSL)	1,1,1-DCA	1,1,1-TCA
CPT-03-01	5/26/2000	28.5-29	704.5-704	ND	ND
CPT-03-02	5/26/2000	41.5-42	691.5-691	ND	ND
CPT-03-03	5/26/2000	53.5-54	679.5-679	ND	1 J
CPT-03-04	5/26/2000	67.5-68	665.5-665	ND	2 J
CPT-03-05	5/26/2000	83.5-84	649.5-649	0.5 J	ND
CPT-03-06	5/26/2000	91.5-92	641.5-641	ND	0.9 J
CPT-03-07	6/2/2000	101.5-102	631.5-631	ND	0.8 J

LEGEND

SURFACE WATER

MUNICIPAL WELL

GROUNDWATER MONITORING LOCATION

S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL

MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)

SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)

EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED

CONSTITUENT EXCEEDS LOWEST AVAILABLE ECOTOX FRESHWATER STANDARDS BUT IS BELOW THE LOWEST GROUNDWATER STANDARDS

CONSTITUENT EXCEEDS BOTH GROUNDWATER STANDARDS AND ECOTOX FRESHWATER STANDARDS

NOTES:

1. THE GROUNDWATER STANDARDS AS DEFINED BY MCLs AND IEPA TIER I GROUNDWATER REMEDIATION OBJECTIVES.
2. THE LOWEST ECOLOGICAL RISK-BASED FRESHWATER STANDARD, AS DEFINED BY THE LOWEST AVAILABLE U.S.EPA ECOTOX THRESHOLDS AND THE MOST CONSERVATIVE WATER QUALITY CRITERIA FOR THE PROTECTION OF ACQUATIC LIFE LISTED IN THE COMPENDIUM OF ENVIRONMENTAL BENCHMARKS (ENVIRONMENT CANADA 1999).
3. PARCEL, ADDRESS INFORMATION, AND STREET DRAWINGS PROVIDED BY WINNEBAGO COUNTY, ILLINOIS.
4. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).
5. ALL UNITS ARE IN ug/L.

SOURCE:

- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

N

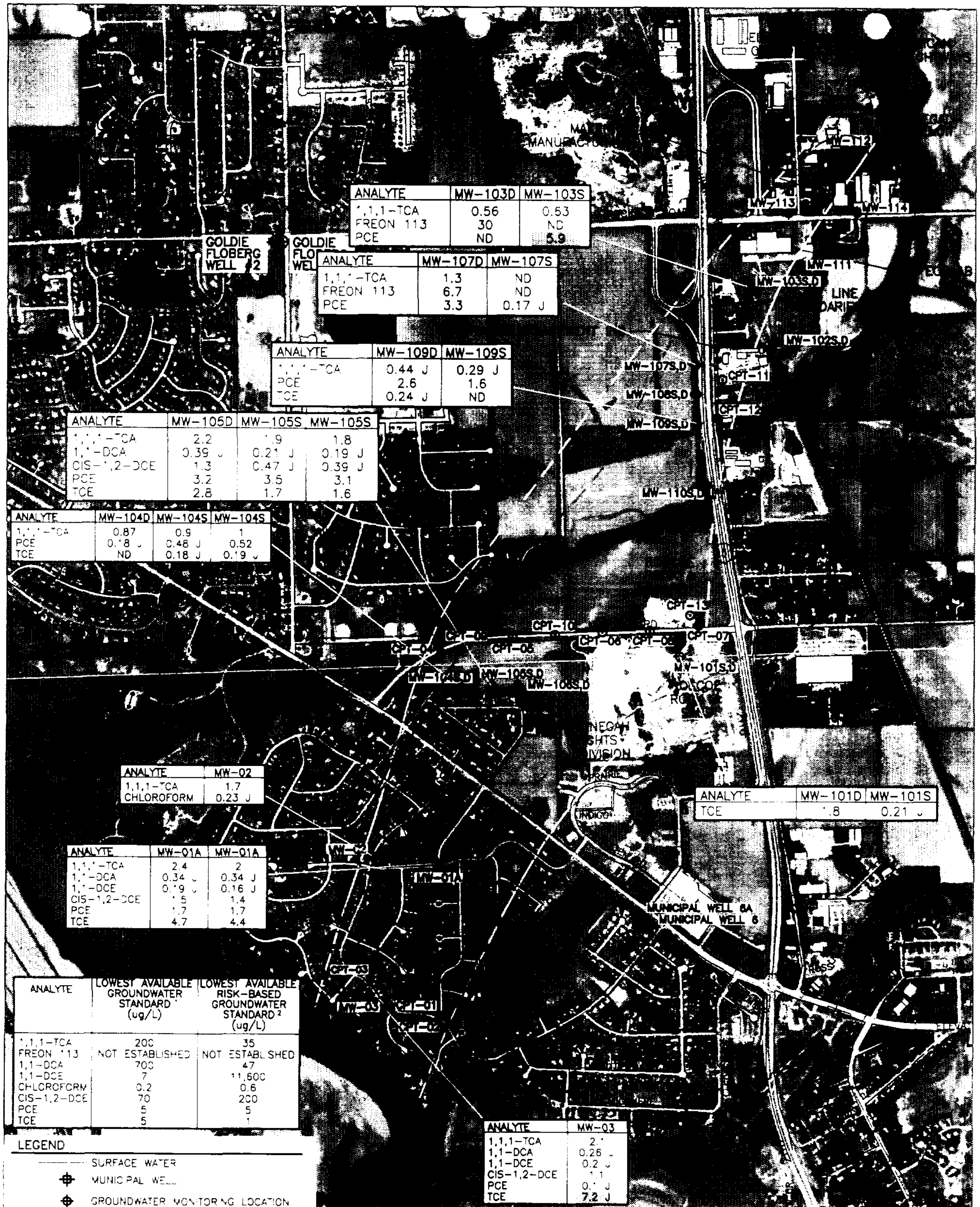
0 1200'

SCALE

FIGURE 1-7

RESPONSE ACTION CONTRACT
U.S. EPA CONTRACT No. 68-W7-0026
WORK ASSIGNMENT No. 139-RICO-05MZ
DOCUMENT CONTROL No. RFW139-2A-ANPK

2000 REMEDIAL INVESTIGATION GROUNDWATER ANALYTICAL RESULTS
EVERGREEN MANOR SITE
Roscoe, Illinois



ANALYTE	MW-103D	MW-103S
1,1,1-TCA	0.56	0.53
FREON 113	30	ND
PCE	ND	5.9

ANALYTE	MW-107D	MW-107S
1,1,1-TCA	1.3	ND
FREON 113	6.7	ND
PCE	3.3	0.17 J

ANALYTE	MW-109D	MW-109S
1,1,1-TCA	0.44 J	0.29 J
PCE	2.6	1.6
TCE	0.24 J	ND

ANALYTE	MW-105D	MW-105S	MW-105S
1,1,1-TCA	2.2	1.9	1.8
1,1-DCA	0.39 J	0.21 J	0.19 J
CIS-1,2-DCE	1.3	0.47 J	0.39 J
PCE	3.2	3.5	3.1
TCE	2.8	1.7	1.6

ANALYTE	MW-104D	MW-104S	MW-104S
1,1,1-TCA	0.87	0.9	1
PCE	0.18 J	0.48 J	0.52
TCE	ND	0.18 J	0.19 J

ANALYTE	MW-02
1,1,1-TCA	1.7
CHLOROFORM	0.23 J

ANALYTE	MW-101D	MW-101S
TCE	1.8	0.21 J

ANALYTE	MW-01A	MW-01A
1,1,1-TCA	2.4	2
1,1-DCA	0.34 J	0.34 J
1,1-DCE	0.19 J	0.16 J
CIS-1,2-DCE	1.5	1.4
PCE	1.7	1.7
TCE	4.7	4.4

ANALYTE	LOWEST AVAILABLE GROUNDWATER STANDARD [1] (ug/L)	LOWEST AVAILABLE RISK-BASED GROUNDWATER STANDARD [2] (ug/L)
1,1,1-TCA	200	35
FREON 113	NOT ESTABLISHED	NOT ESTABLISHED
1,1-DCA	700	47
1,1-DCE	7	11,600
CHLOROFORM	0.2	0.6
CIS-1,2-DCE	70	200
PCE	5	5
TCE	5	1

ANALYTE	MW-03
1,1,1-TCA	2.1
1,1-DCA	0.26 J
1,1-DCE	0.2 J
CIS-1,2-DCE	1.1
PCE	0.1 J
TCE	7.2 J

LEGEND

SURFACE WATER

MUNICIPAL WELL

GROUNDWATER MONITORING LOCATION

S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL

MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)

EXTENT OF DETECTIONS - DASHED WHERE INFERRED

EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED

CONSTITUENT EXCEEDS BOTH GROUNDWATER STANDARDS AND ECOTOX STANDARDS

CONSTITUENT EXCEEDS LOWEST AVAILABLE ECOTOX FRESHWATER STANDARDS BUT IS BELOW THE LOWEST GROUNDWATER STANDARDS

CONSTITUENT EXCEEDS LOWEST GROUNDWATER STANDARDS BUT IS BELOW THE LOWEST ECOLOGICAL FRESHWATER STANDARD

NOTES:

1. CONSTITUENT EXCEEDS LOWEST GROUNDWATER STANDARDS AS DEFINED BY MCLs AND IEPA TIER I GROUNDWATER REMEDIATION OBJECTIVES
2. CONSTITUENT EXCEEDS THE LOWEST ECOLOGICAL RISK-BASED FRESHWATER STANDARD, AS DEFINED BY THE LOWEST AVAILABLE U.S.EPA ECOTOX THRESHOLDS AND THE MOST CONSERVATIVE WATER QUALITY CRITERIA FOR THE PROTECTION OF ACQUATIC LIFE LISTED IN THE COMPENDIUM OF ENVIRONMENTAL BENCHMARKS (ENVIRONMENT CANADA 1999).
3. PARCEL, STREET DRAWINGS, AND ADDRESS INFORMATION PROVIDED BY WINNEBAGO COUNTY.
4. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION)
5. ALL UNITS ARE IN ug/L.

SOURCE:

- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

N

0 1200'

SCALE

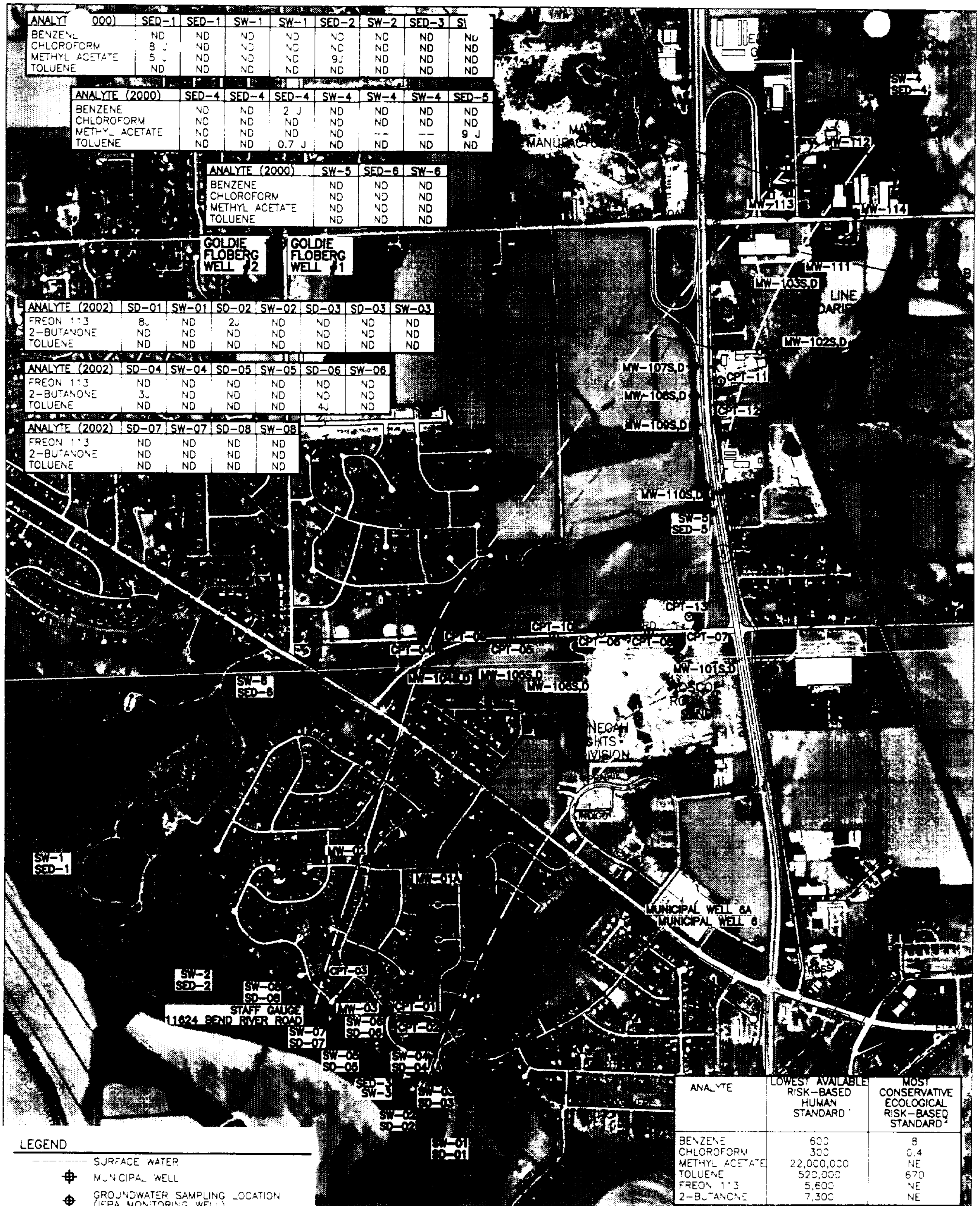
FIGURE 1-8

RESPONSE ACTION CONTRACT
U.S. EPA CONTRACT No. 68-W7-0026
WORK ASSIGNMENT No. 139-RICO-05MZ
DOCUMENT CONTROL No. RFW139-2A-ANPK

APRIL 2002 GROUNDWATER ANALYTICAL RESULTS

EVERGREEN MANOR SITE

Roscoe, Illinois



ANALYT[illegible]000)	SED-1	SED-1	SW-1	SW-1	SED-2	SW-2	SED-3	S[illegible]
BENZENE	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROFORM	8 J	ND	ND	ND	ND	ND	ND	ND
METHYL ACETATE	5 J	ND	ND	ND	9J	ND	ND	ND
TOLUENE	ND	ND	ND	ND	ND	ND	ND	ND

ANALYTE (2000)	SED-4	SED-4	SED-4	SW-4	SW-4	SW-4	SED-5
BENZENE	ND	ND	2 J	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND	ND	ND
METHYL ACETATE	ND	ND	ND	ND	--	--	9 J
TOLUENE	ND	ND	0.7 J	ND	ND	ND	ND

ANALYTE (2000)	SW-5	SED-6	SW-6
BENZENE	ND	ND	ND
CHLOROFORM	ND	ND	ND
METHYL ACETATE	ND	ND	ND
TOLUENE	ND	ND	ND

ANALYTE (2002)	SD-01	SW-01	SD-02	SW-02	SD-03	SD-03	SW-03
FREON 113	8J	ND	2J	ND	ND	ND	ND
2-BUTANONE	ND	ND	ND	ND	ND	ND	ND
TOLUENE	ND	ND	ND	ND	ND	ND	ND

ANALYTE (2002)	SD-04	SW-04	SD-05	SW-05	SD-06	SW-06
FREON 113	ND	ND	ND	ND	ND	ND
2-BUTANONE	3J	ND	ND	ND	ND	ND
TOLUENE	ND	ND	ND	ND	4J	ND

ANALYTE (2002)	SD-07	SW-07	SD-08	SW-08
FREON 113	ND	ND	ND	ND
2-BUTANONE	ND	ND	ND	ND
TOLUENE	ND	ND	ND	ND

ANALYTE	LOWEST AVAILABLE RISK-BASED HUMAN STANDARD [1]	MOST CONSERVATIVE ECOLOGICAL RISK-BASED STANDARD [2]
BENZENE	600	8
CHLOROFORM	300	0.4
METHYL ACETATE	22,000,000	NE
TOLUENE	520,000	670
FREON 113	5,600	NE
2-BUTANONE	7,300	NE

LEGEND

- SURFACE WATER
- MUNICIPAL WELL
- GROUNDWATER SAMPLING LOCATION (IEPA MONITORING WELL)
- S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL
- STAFF GAUGE
- SURFACE WATER AND SEDIMENT SAMPLING LOCATION (APRIL 2002)
- APPROXIMATE SEDIMENT AND SURFACE WATER SAMPLING LOCATION (MAY 2000)
- MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)
- SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)
- EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED
- CONSTITUENT EXCEEDS LOWEST AVAILABLE ECOTOX FRESHWATER STANDARDS

NOTES:

1. CONSTITUENT EXCEEDS THE LOWEST SEDIMENT STANDARDS AS DEFINED BY U.S. EPA REGION IX PRELIMINARY REMEDIATION GOALS (PRGs) AND IEPA SOIL REMEDIATION FOR RESIDENTIAL USAGE.
2. CONSTITUENT EXCEEDS THE LOWEST SEDIMENT STANDARDS AS DEFINED BY U.S. EPA ECOTOX THRESHOLDS FOR SEDIMENT AND THE MOST CONSERVATIVE SEDIMENT CRITERIA LISTED IN THE COMPENDIUM OF ENVIRONMENTAL BENCHMARKS (ENVIRONMENT CANADA, 1990)
3. SEDIMENT RESULTS = ug/kg
   SURFACE WATER RESULTS = ug/L
4. PARCEL, ADDRESS INFORMATION, AND STREET DRAWINGS PROVIDED BY WINNEBAGO COUNTY, ILLINOIS.
5. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).

SOURCE:

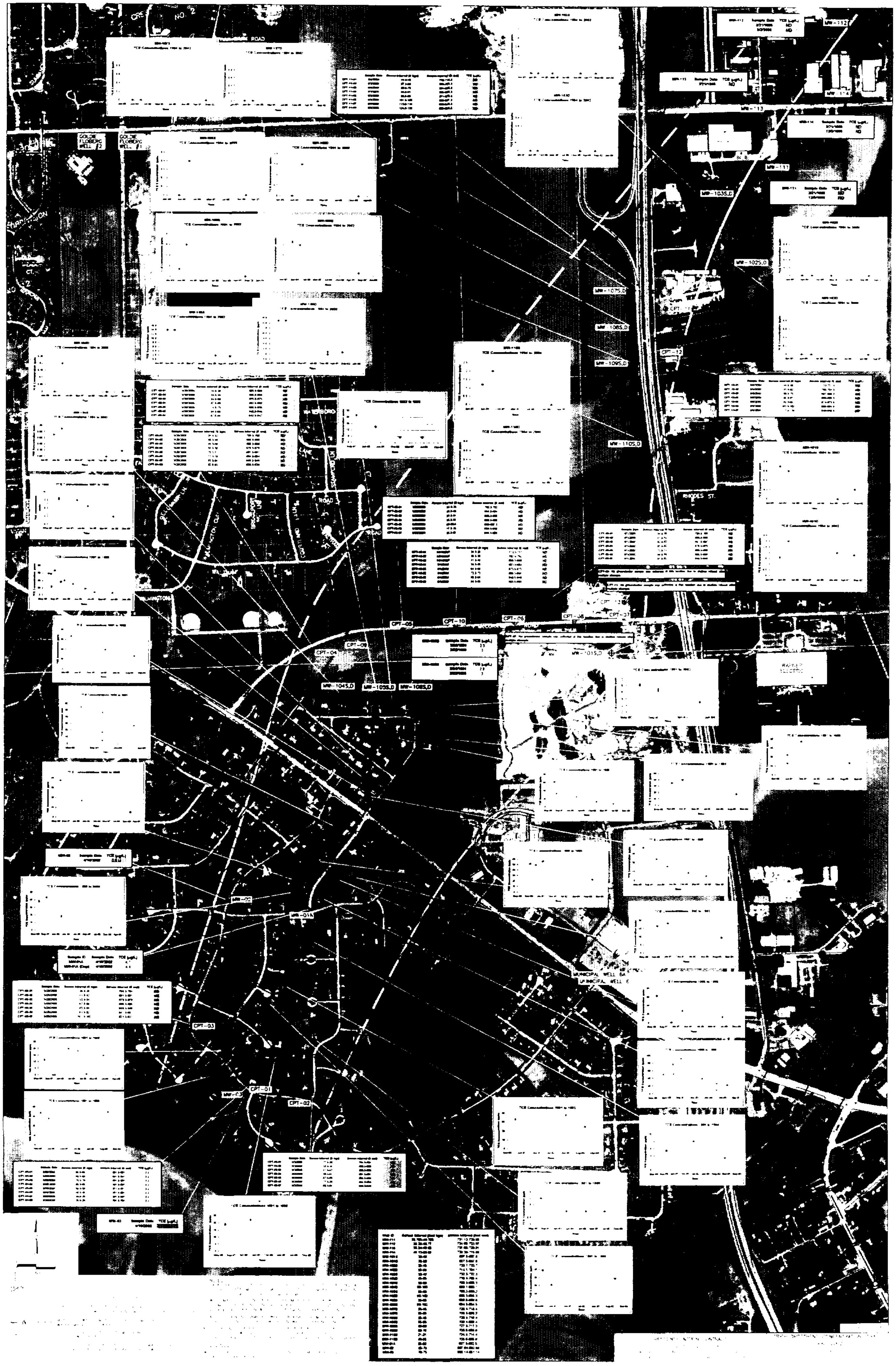
- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

0 1200'

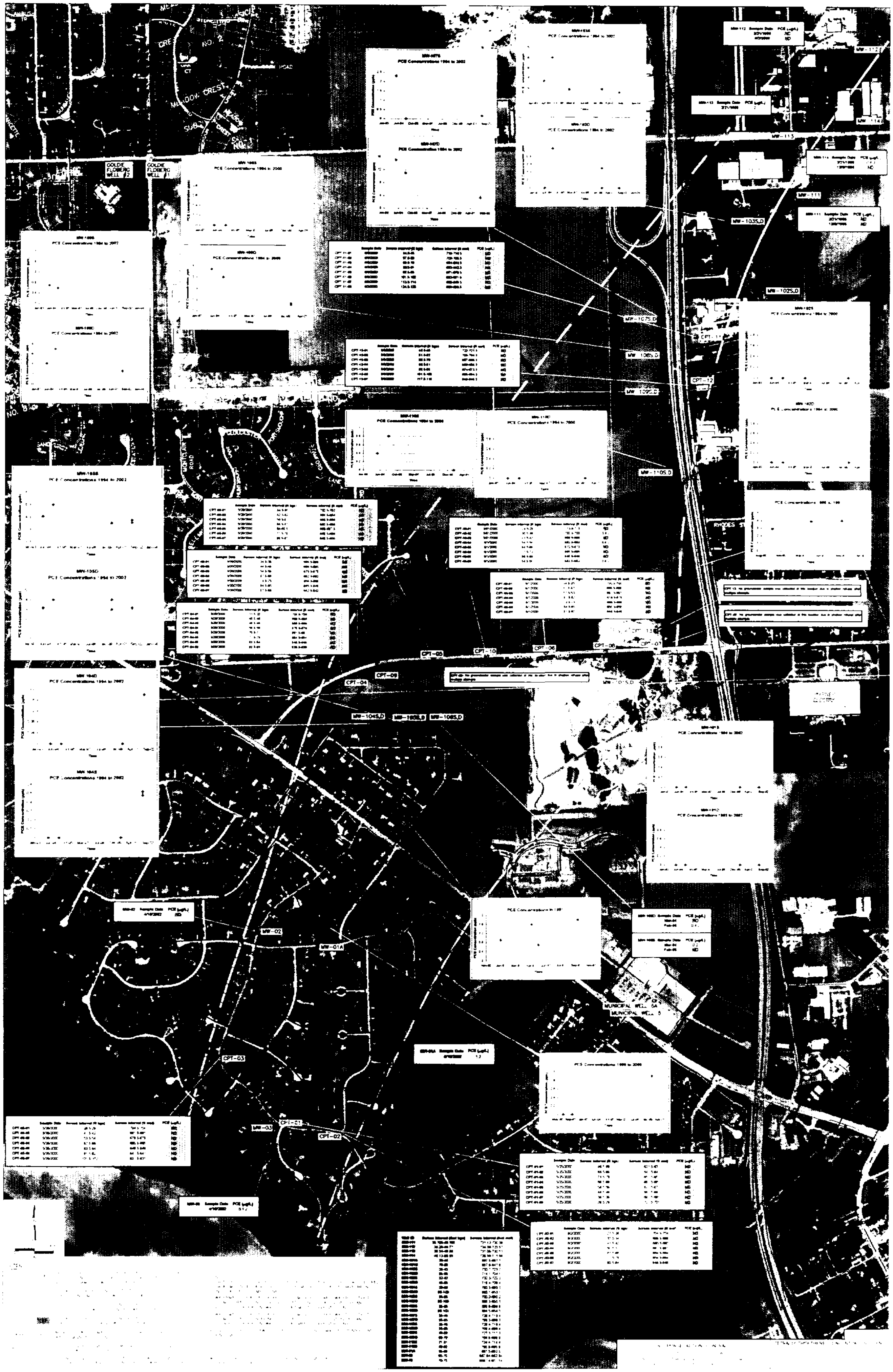
SCALE

FIGURE 1-9

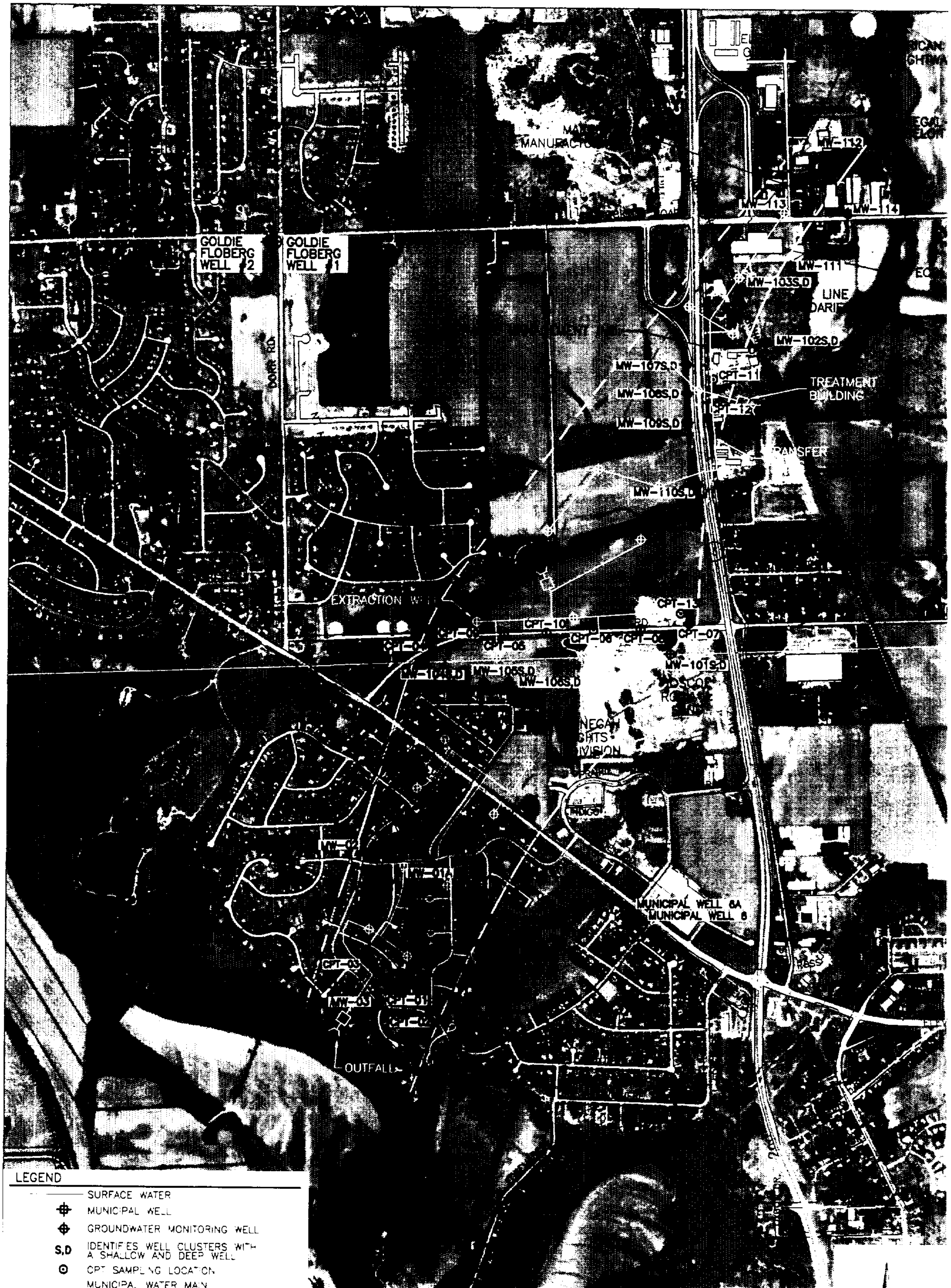
RESPONSE ACTION CONTRACT	2000 AND 2002 REMEDIAL INVESTIGATION SEDIMENT AND SURFACE WATER ANALYTICAL RESULTS
U.S. EPA CONTRACT No. 68-W7-0026	EVERGREEN MANOR SITE
WORK ASSIGNMENT No. 139-RICO-05MZ	Roscoe, Illinois
DOCUMENT CONTROL No. RFW139-2A-ANPK	



GOLDIE FLOBERG WELL #2
GOLDIE FLOBERG WELL #1
ROAD
MW-112
MW-113
MW-111
MW-103S,D
MW-102S,D
MW-107S,D
MW-108S,D
MW-109S,D
MW-110S,D
CPT-13
RHODES ST.
CPT-05
CPT-10
CPT-06
CPT-08
CPT-09
CPT-04
MW-101S,D
MW-104S,D
MW-105S,D
MW-106S,D
WARNER ELECTRIC
MW-02
MW-01A
CPT-03
CPT-01
CPT-02
MW-03
MUNICIPAL WELL



GOLDIE FLOBERG WELL #2
GOLDIE FLOBERG WELL #1
MEADOW CREST
MW-113
MW-111
MW-103S,D
MW-102S,D
MW-107S,D
MW-106S,D
MW-105S,D
MW-110S,D
CPT-12
RHODES ST
CPT-05
CPT-10
CPT-06
CPT-08
CPT-07
CPT-09
CPT-04
MW-104S,D
MW-108S,D
MW-02
MW-01A
MUNICIPAL WELL 6
MUNICIPAL WELL 5
CPT-03
MW-03
CPT-01
CPT-02
PCE Concentrations 1994 to 2002



LEGEND

- SURFACE WATER
- MUNICIPAL WELL
- GROUNDWATER MONITORING WELL
- S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL
- CPT SAMPLING LOCATION
- MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)
- SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)
- EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED
- PROPOSED EXTRACTION WELL
- PROPOSED TREATMENT BUILDING
- PROPOSED TRANSFER PIPING
- PROPOSED RIVER OUTFALL

NOTES:

1. BASE MAP ADAPTED FROM CAD FILES PROVIDED BY WINNEBAGO COUNTY AND ORTHO (USGS, 1999).
2. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).

SOURCES:

- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

FIGURE 4-1

RESPONSE ACTION CONTRACT	ALTERNATIVE 2: GENERAL LAYOUT
U.S. EPA CONTRACT No. 68-W7-0026 WORK ASSIGNMENT No. 139-RICO-05MZ DOCUMENT CONTROL No. RFW139-2A-ANPK	EVERGREEN MANOR SITE Roscoe, Illinois

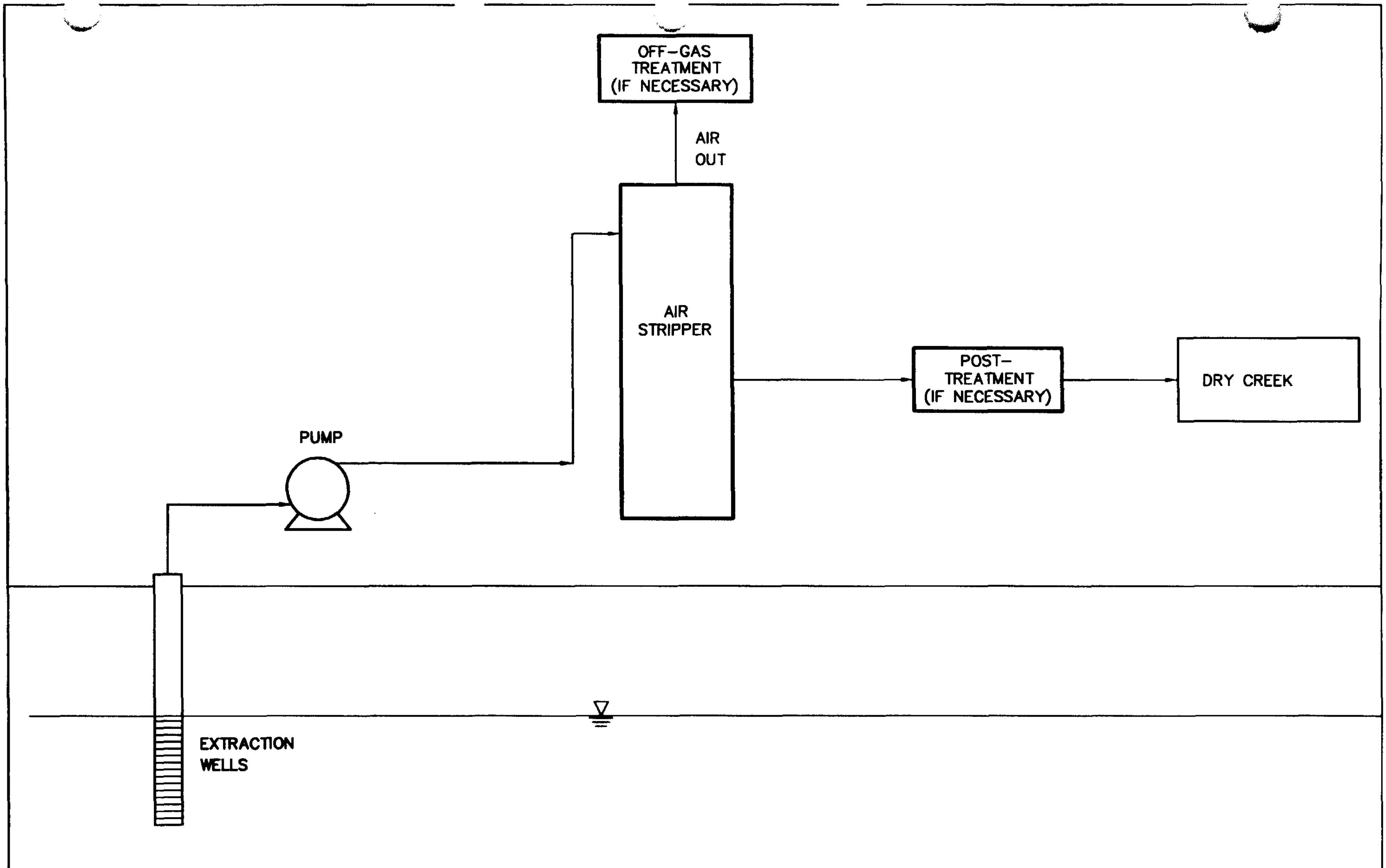
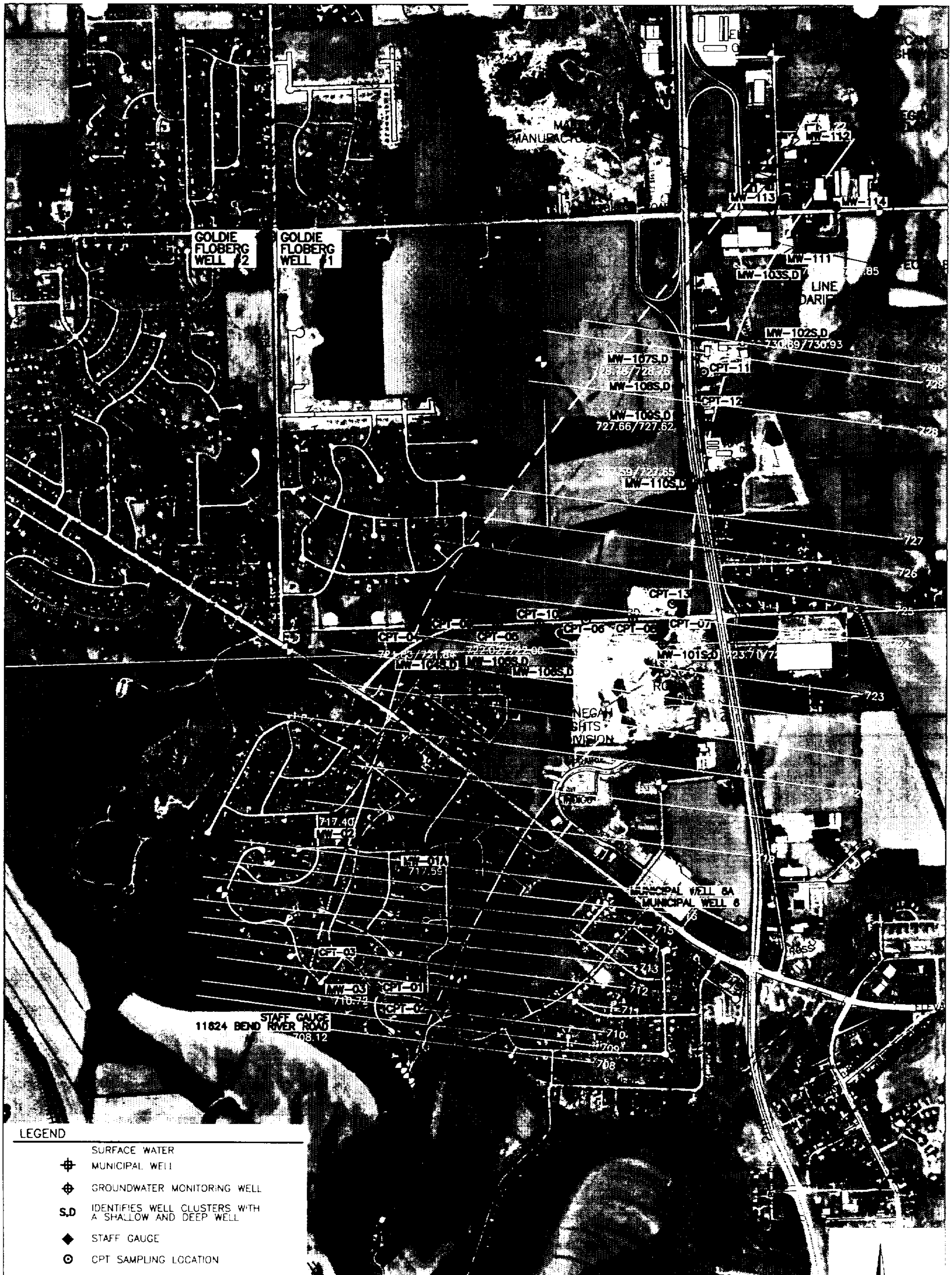


FIGURE 4-2

RESPONSE ACTION CONTRACT
U.S. EPA CONTRACT No. 68-W7-0026
WORK ASSIGNMENT No. 139-RICO-05MZ
DOCUMENT CONTROL No. RFW139-2A-ANPK

PROCESS FLOW SCHEMATIC OF PUMP-AND-TREAT SYSTEM
EVERGREEN MANOR SITE
Roscoe, Illinois



LEGEND

- SURFACE WATER
- MUNICIPAL WELL
- GROUNDWATER MONITORING WELL
- S,D IDENTIFIES WELL CLUSTERS WITH A SHALLOW AND DEEP WELL
- STAFF GAUGE
- CPT SAMPLING LOCATION
- MUNICIPAL WATER MAIN (NOT ALL HOMES ALONG THE WATER MAIN ARE CONNECTED)
- SITE BOUNDARY (BASED ON MAXIMUM EXTENT OF VOC)
- EXTENT OF VOC DETECTIONS IN GROUNDWATER (BASED ON 2000 AND 2002 INVESTIGATION) DASHED WHERE INFERRED
- PROPOSED PIEZOMETER LOCATION

NOTES:

1. BASE MAP ADAPTED FROM CAD FILES PROVIDED BY WINNEBAGO COUNTY AND ORTHO (USGS, 1999).
2. WATERMAIN LOCATIONS ADAPTED FROM NORTH PARK WATER DISTRICT BY McCLURE ENGINEERING ASSOCIATES, INC. (2002 VERSION) AND VILLAGE OF ROCKTON WATER DEPARTMENT (1998 VERSION).

SOURCES:

- USGS EARTH SOURCES OBSERVATION SYSTEMS DATA CENTER DATED: 1999/04/24.

N

0 1200'

SCALE

FIGURE 4-3

RESPONSE ACTION CONTRACT	PROPOSED PIEZOMETER LOCATIONS
U.S. EPA CONTRACT No. 68-W7-0026 WORK ASSIGNMENT No. 139-RICO-05MZ DOCUMENT CONTROL No. RFW139-2A-ANPK	EVERGREEN MANOR SITE Roscoe, Illinois

FIGURE 1-5

SE ACTION CONTRACT
NTRACT No. 68-W7-0026
ENT No. 139-RICO-05MZ
TROL No. RFW139-2A-ANPK

NORTH PARK PUBLIC WATER DISTRIBUTION NETWORK
EVERGREEN MANOR SITE
Roscoe, Illinois

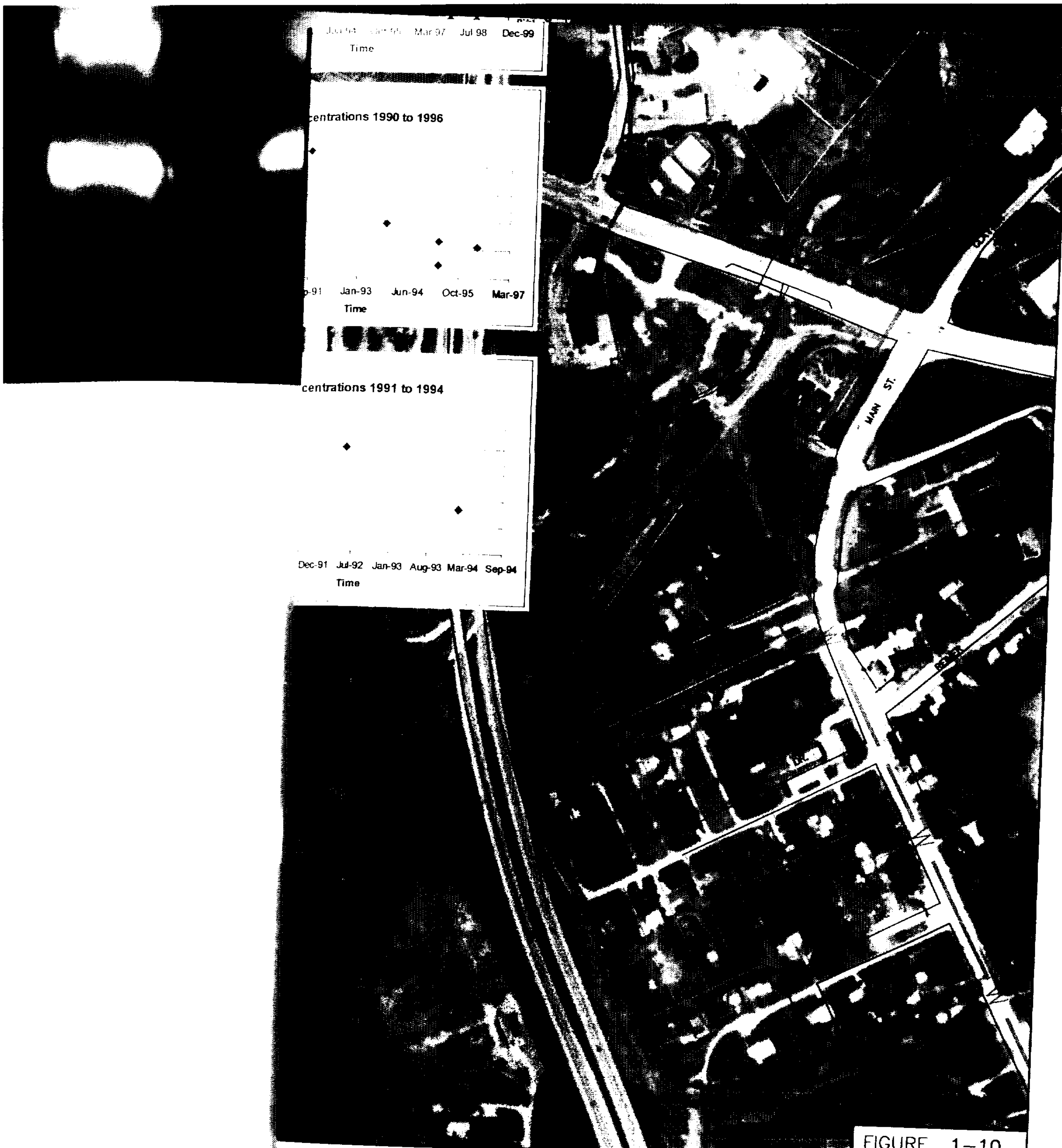


FIGURE 1-10

ACTION CONTRACT
RACT No. 68-W7-0026
NT No. 139-RICO-05MZ
OL No. RFW139-2A-ANPK

TRICHLOROETHENE CONCENTRATION TRENDS
1990-2002
EVERGREEN MANOR SITE
Roscoe, Illinois

FIGURE 1–11

E ACTION CONTRACT TRACT No. 68–W7–0026 ENT No. 139–RICO–05MZ ROL No. RFW139–2A–ANPK	TETRACHLOROETHENE CONCENTRATION TRENDS EVERGREEN MANOR SITE Roscoe, Illinois

Appendix A

APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

A.1 INTRODUCTION

This Appendix provides an analysis of the applicable or relevant and appropriate requirements (ARARs) for the feasibility study (FS) for Evergreen Manor Site in Roscoe, Illinois.

A.1.1 ARAR Definition

The basis for ARARs is cited in Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments Reauthorization Act (SARA), which requires that Superfund-financed enforcement and federal facility remedial actions comply with all applicable or relevant and appropriate federal environmental or promulgated state environmental or facility siting laws. "For the purposes of identification and notification of promulgated state standards, the term ***promulgated*** means that the standards are of general applicability and are legally enforceable" [National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) 300.400(g)(4)]. The most stringent promulgated standards are applied as ARAR (Preamble to National Contingency Plan [NCP], 55 FR 8741, 8 March 1990).

"Applicable requirements," as defined in 40 CFR 300.5, are "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable."

"Relevant and appropriate requirements," also defined in 40 CFR 300.5, are "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate."

A.1.2 To Be Considered ARARS

In addition to ARARs, advisories, criteria, or guidance may be identified "to be considered" (TBC) for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category "consists of advisories, criteria, or guidance developed by the U.S. Environmental Protection Agency, other federal agencies, or states that may be useful in developing CERCLA remedies." Use of TBCs is discretionary rather than mandatory, as opposed to the use of ARARs, which is mandatory.

A.1.3 ARAR Categories

In general, there are three categories of ARARs:

- Ambient or chemical-specific requirements.
- Location-specific requirements.
- Performance, design, or other action-specific requirements.

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. If a chemical has more than one such requirement that is ARAR, the most stringent generally should be complied with.

A site's location is a fundamental determinant of its impact on human health and the environment. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. An example of a location-specific requirement is the substantive Clean Water Act (CWA) §404 prohibitions of the unrestricted discharge of dredged or fill material into wetlands.

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, very different requirements can come into play. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved.

A.2 <u>IDENTIFICATION AND EVALUATION OF ARARS</u>

Development of a preliminary list of potential chemical-specific ARARs allows the establishment of a list of preliminary remediation goals (PRGs) or screening levels in the FS process, which is essentially a tentative listing of contaminants together with initially anticipated clean-up concentrations or risk-based levels for each medium. Preliminary remediation goals serve to focus the development of alternatives bused on remedial technologies that can achieve the remediation goals, thereby limiting the number of alternatives to be considered in the detailed remedial alternative analysis, conducted later in the FS process.

At the beginning of the FS process, a preliminary consideration of location- and action-specific ARARs is commonly conducted. As remedial alternatives are screened during the FS, action-specific ARARs are identified. When the detailed analysis of the remedial alternatives is conducted, all action-specific ARARs are refined to a much more detailed form with respect to each alternative before a comparison of alternatives begins. The chemical-specific, location-specific and action-specific ARARs for the Evergeen Manor site are discussed in the following subsections.

A.2.1 Chemical-Specific ARARS

Health-based, chemical-specific ARARs pertinent to contaminants of concern identified for groundwater are presented here. The chemical-specific ARARs are primarily derived from federal and state health and environmental statutes and regulations. As discussed below, in some instances these standards are classified as items "to be considered." A summary of potential chemical-specific ARARs for the contaminants at the Evergreen Manor site is presented in Tables A-1 and A-2. Table A-1 presents the potential Federal chemical-specific ARARs and includes an evaluation of whether these standards are applicable to the Evergreen Manor site. Similarly, Table A-2 presents and evaluates the potential Illinois chemical-specific ARARs.

A.2.2 Location-Specific ARARS

Location-specific ARARs are statutes or regulations which set restrictions on activities or limits on contaminant levels solely because of location, e.g., within a floodplain, wetland, historic place, or sensitive ecosystem or habitat. The potential location-specific ARARs are presented and evaluated in Tables A-3 and A-4. Table A-3 presents federal ARARs and Table A-4 presents Illinois ARARs.

A.2.3 Action-Specific ARARS

Performance, design, and other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are not triggered by the specific chemicals present at a site, but rather by site characterization activities and remedial actions. Potential action-specific ARARs are technology-based performance standards, such as the Best Available Technology standard of the Federal Water Pollution Control Act. Other examples include Resource Conservation and Recovery Act (RCRA) treatment, storage, and disposal standards, and CWA pre-treatment standards for discharges to publicly-owned treatment works. The selection of appropriate action-specific ARARs is based on the general response actions. The general response actions are as follows:

- No action - provides a baseline for comparison with other alternatives and is required by the NCP for the FS process.
- Institutional controls - prevent human exposure to the identified contaminants of concern (COCs) but do not address reducing the toxicity, mobility, or volume of contamination.
- Containment - limits or controls the migration of contaminants beyond the present area of contamination into adjacent areas but does not contribute to reducing the toxicity or volume of contamination.
- Collection - removes contaminated media to facilitate treatment or disposal actions.
- Treatment - uses processes, implemented *in situ*, on site, or off site, to reduce the toxicity, mobility, or volume of contaminants in the affected media.

- Natural Attenuation - allows natural subsurface process (such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials) to reduce contaminant concentrations to acceptable levels.

- Disposal (in association with the collection or treatment actions) - determines the ultimate location of treated or untreated media in an environmentally sound, publicly acceptable, and cost-effective manner.

The potential action-specific ARARs based on the general response actions described above are presented and evaluated in Tables A-5 and A-6. Table A-5 presents federal ARARs and Table A-6 presents Illinois ARARs.

A.3 APPLICABILITY OF ARARS TO THE FINAL REMEDY

CERCLA §121 specifically requires attainment of all ARARs. Moreover, as explained in the preamble to the NCP (55 FR 8741), in order to attain all ARARs a remedial action must comply with the most stringent requirement, which then ensures attainment of all other ARARs. Furthermore, CERCLA requires that the remedies selected must attain ARARs and be protective of human health and the environment. Consequently, PRGs (screening levels) based on ARARs require modification based on information and data that are collected in the RI or other investigations, including the baseline risk assessment, or when ARARs are not available or are determined to be inadequate for protection of human health and the environment.

Development of remediation goals is actually a portion of the overall development of remedial action objectives, which ultimately will define the required endpoint of the selected remedial action. As stated in the preamble to the NCP (55 FR 8712-8713), "remedial action objectives are the more general description of what the remedial action will accomplish. Remediation goals are a subset of remedial action objectives and consist of medium-specific or operable unit-specific chemical concentrations that are protective of human health and the environment and serve as goals for the remedial action. The remedial action objectives should specify: (1) the contaminants of concern, (2) the exposure routes and receptors, and (3) an acceptable contaminant level or range of levels for each exposure medium (i.e., a preliminary remediation goal)." Remediation goals will establish acceptable exposure levels, per 40 CFR 300.430 (e)(2)(i), which are protective of human health and the environment and will be developed by considering the following:

- ARARs (chemical-specific).
  - Acceptable exposure levels for systemic toxicants.
  - Acceptable exposure levels for known or suspected carcinogens (10^{-6} to 10^{-4} risk levels).
  - Technical limitations (e.g., detection limits).
  - Uncertainty factors.
  - Other pertinent information.
- Maximum Contaminant Level Goals (MCLGs) (or MCLs where MCLGs are zero) where relevant and appropriate.
- Acceptable exposure levels where multiple contaminants or multiple exposure pathways will cause exposure at ARAR levels resulting in cumulative risk in excess of 10^{-4}.
- CWA ambient water quality criteria, where relevant and appropriate.
- A CERCLA Alternative Concentration Limit (ACL) established pursuant to CERCLA § 121(d)(2)(B)(ii).
- Environmental evaluations shall be performed to assess threat to the environment, especially sensitive habitats and critical habitat of species protected under the Endangered Species Act.

Once a preferred remedial action alternative is formally selected, all chemical-, location-, and action-specific ARARs are identified. If it is found that the most suitable remedial alternative does not meet an ARAR, the NCP provides for waivers of ARARs under certain circumstances. According to 40 CFR 300.430(f)(1)(ii)(C),

> "An alternative that does not meet an ARAR under federal environmental or state environmental or facility siting laws may be selected under the following circumstances:
>
> (1) The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement;
>
> (2) Compliance with the requirement will result in greater risk to human health and the environment than other alternatives;
>
> (3) Compliance with the requirement is technically impracticable from an engineering perspective;
>
> (4) The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach;
>
> (5) With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state; or
>
> (6) For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites may present a threat to human health and the environment."

Accordingly, if any of the alternatives selected for the Evergreen Manor site are expected to not attain an ARAR, this expectation must be expressed together with an appropriate justification that relates to at least one of the ARAR waiver circumstances identified above.

From this point, the alternative will become the final remedy as it is incorporated into the ROD. Once the final Record of Decision (ROD) has been signed, requirements must be modified only when they are determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment [40 CFR 300.430(f)(1)].

Appendix B

APPENDIX B

DESCRIPTION OF REMEDIAL TECHNOLOGIES

This appendix provides descriptions of remedial technologies considered for implementation at the Evergreen Manor site. Technologies are presented for groundwater .

B.1 PROCESS OPTIONS FOR GROUNDWATER

The following subsections present descriptions of soil remedial technologies considered for implementation at the Evergreen Manor site.

B.1.1 No Action

No action means no remedial action would take place at the site. Current contamination would be left in place, and no changes in contaminant levels would be expected except those resulting from natural processes. The no-action option may not achieve remedial objectives; however, it is retained as the baseline for comparison with other alternatives.

B.1.2 Institutional Controls

B.1.2.1 Monitoring

Long-term Groundwater Monitoring

This process option involves monitoring perched water or groundwater for contaminants leached from impacted soil. Long-term groundwater monitoring requires the installation of monitoring wells at depths such that well screens would lie within the saturated zone. Groundwater samples would be collected on a regular basis (i.e., quarterly, annually, etc.) and analyzed for constituents of concern or other water quality parameters. The data obtained is then used to evaluate site conditions and contaminant migration.

B.1.2.2 Groundwater Use Restrictions

Groundwater Use Restrictions

Groundwater use restrictions, restrict the use of Groundwater, thereby preventing exposure to site contaminants.

B.1.2.3 Access Restrictions

Fencing

Access restrictions such as fencing create a barrier to prevent human access to the site. Legal restrictions and placement of signs (i.e, "no trespassing," "hazardous waste site," etc.) along the property boundary can be also used to deter human access.

B.1.3 Containment

B.1.3.1 Vertical Barrier

Vertical barriers are installed around the perimeter of a contaminated soil area to prevent lateral migration of contaminants in groundwater passing through the contaminated soil. Applicable primarily in saturated or smear (capillary fringe) zone.

Slurry Wall

A slurry wall is constructed by excavating a vertical trench and simultaneously backfilling it with a slurry. The slurry would be a mixture consisting of soil, bentonite, and water, which helps prevent collapse during excavation and provides a low permeability barrier to control the lateral migration of contaminants.

Slurry Columns

Slurry columns form a vertical barrier similar to the slurry wall. Construction of slurry columns involves augering through the subsurface with specialized drilling equipment consisting of a row of closely-spaced augers suspended from a crane. The borings created by the augers are overlapped to prevent gaps between the columns. As the augers advance to the desired depth, bentonite would be added through the center of the augers and is mixed with the soil being penetrated. The soil would be mixed again as the augers are withdrawn, and a low permeability barrier would be formed.

Sheet Piling

Sheet piles may be driven using impact or vibratory hammers. Depths of up to 80 ft are possible; however, the thickness of the sheet pile must be increased at the depth is increased to prevent buckling due to frictional forces that build along the face of the sheet pile during driving. Subsurface features such as boulders or interbedded clays and gravels may inhibit the effective depth that sheet piles can be driven. Conventional sheet piles have interlocking joints that are not entirely watertight; therefore, some groundwater may pass through the joints. Sealable sheet piles are manufactured which have a joint that may be filled with grout; however, uniform application of the grout along the entire depth of the joint may be difficult. Although some portions of the joints may allow seepage, considerable more area of the joint is effectively sealed, reducing the infiltration potential of the groundwater. Sealable sheet piles are typically usable to depths of approximately 30 to 4 feet (depending on geology), primarily due to lack of thicker pile available.

Grout Curtain

Grout curtains are constructed by injecting grout through tubes temporarily placed in predrilled boreholes. The boreholes would be located along three successive rows to prevent "windows" in the grout curtain. Grout shrinkage and non-overlapping grout injections are associated problems that may leave open areas or gaps in the curtain. Such gaps in the curtain would affect the curtains ability to prevent lateral migration of contaminants.

B.1.4 Collection

B.1.4.1 Vertical Systems

Pumping Well System

A pumping well system could be used to form a hydraulic barrier by manipulating the groundwater flow direction and gradient. The radius of influence created by a network of wells could be used to control the groundwater flow regime and capture or redirect water that would normally flow away from areas of contamination. Wells used primarily for groundwater extraction could also cause a hydraulic barrier to form as a result of pumping. The barrier would be considered temporary because it exists only while the pumping system is operating.

Well Point System

An alternative to pumping wells for groundwater collection and extraction is the installation of well points. Groundwater would be removed from the subsurface through closely spaced well points connected by a main suction header instead of wells with individual pumps. Well points, however, are best suited to shallow aquifers where total lift of water is not greater than 20 ft.

B.1.4.2 Horizontal Systems

Trench Collection System

A trench collection system is a subsurface drain system used to collect and extract groundwater. The system includes sumps and lift pumps to extract the collected water from below the ground surface. This type of extraction system acts as a continuous line of pumping wells and is proven and reliable technology that can provide the control needed to effectively capture the groundwater. Dewatering is required for some types of trench installation. The conventional dewatering technique for trench installation uses well points that are effective only to depths of 20 feet.

Horizontal Well System

Horizontally oriented extraction wells could be used to collect contaminated groundwater. Horizontal wells have been successfully drilled and completed in unconsolidated sediments using short-radius, mud-rotary drilling tools. The overall drilling performance would be controlled by geologic conditions (percentage of fines), rigid drill mandrel configuration, drilling bit speed and weight, and drilling fluid pumping rates. Preferred target zones for optimal drilling performance would contain minor amounts of clay, which improves the competency of the formation. In addition, downhole surveys would be required during the drilling process to record the direction and angle of the borehole.

B.1.5 Treatment

B.1.5.1 *In Situ*: Physical/Chemical

Geochemical Fixation

Inorganic contaminants including heavy metals and radionuclides could be removed from groundwater and fixed onto aquifer material through the process of geochemical fixation. In a pump-and-treat alternative, pumped water would be chemically modified and reinjected to change existing pH and oxidation/reduction conditions and optimize geochemical interactions between the contaminant and the aquifer material. The geochemical reactions of sorption, precipitation and ion-exchange would decrease the concentrations of inorganics in the groundwater.

Chemical Injection

In situ chemical injection involves the subsurface injection of surfactant solutions to groundwater systems contaminated with non-aqueous phase liquids. The solutions increase the effective solubility of organic contaminants by two or three orders of magnitude. Extraction wells would recover the injected surfactant for treatment and reuse. The contaminated groundwater, however, must be contained within a "treatment zone" to ensure that the injected reagents do not migrate and unintentionally affect other areas. The effect of the injected chemicals and their reaction products on the site must also be considered.

Permeable Reactive Barrier

Permeable reactive barriers (PRBs) are trenches excavated perpendicular to the groundwater flow direction and backfilled with a reactor material. These barriers allow the passage of water while prohibiting the movement of contaminants by employing such agents as chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others. The treatment materials could include an iron-based reactor material, limestone, carbon, or glauconite. The limestone and glauconite treatment materials would be for removal of heavy metals. The iron-based reactor material and carbon material would be used for removal of chlorinated organic contaminants. Limitations of this process include saturation or plugging of the treatment material.

Hydrolysis

Hydrolysis is the use of water to destroy, decompose, or alter a organic chemical contaminant to render it less toxic. The rate of hydrolysis and formation of end products is strongly influenced by the pH of the water being treated. This technology is rarely used for *in situ* applications because it is difficult to predict the by-product formation, and very sensitive process controls are required.

Oxidation

Organic compounds in groundwater could potentially be degraded *in situ* by reaction with oxidants like ozone or hydrogen peroxide. The oxidants would be either injected into the groundwater through wells or infiltrated into the groundwater through subsurface trenches. *In situ* oxidation is limited in application because it is difficult to monitor and to control by-product formation. Hence, *ex situ* (on site) oxidation is more applicable.

Reductive Dechlorination using Hydrogen

Hydrogen or hydrogen-releasing compounds (i.e., esters) are added to the subsurface to create reducing conditions, which stimulate the activity of reductive dechlorinating bacteria. Chlorinated VOCs are reduced by replacing the chlorine ions on the molecules with hydrogen. If conditions are strongly reducing, reductive dechlorinaton process may effectively end with dichloroethenes as the end product.

Air Sparging

Air sparging involves forcing air into the aquifer, causing volatilization of VOCs. The air sparging system consists of an array of injection and extraction wells. Extraction wells would be located above the water table. Vacuum pumps would be used to extract contaminant vapors through the extraction wells. The injection wells would be located below the water table to facilitate air movement through the contaminated groundwater and enhance bioremediation by providing oxygen.

Directional Wells

Drilling techniques are used to position wells horizontally, or at an angle, in order to reach contaminants not accessible via direct vertical drilling.

Dual Phase Extraction

A high vacuum system is applied to simultaneously remove liquid and gas from low permeability or heterogeneous formations.

Free Product Recovery

Undissolved liquid-phase organics are removed from subsurface formations, either by active methods (e.g., pumping) or a passive collection system.

Hot Water and Steam Flushing

Steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone where they are removed by vacuum extraction and then treated.

Hydrofracturing

Injection of pressurized water through wells cracks low permeability and over-consolidated sediments. Cracks are filled with porous media that serve as avenues for bioremediation or to improve pumping efficiency.

Vacuum Vapor Extraction

Air is injected into a well, lifting contaminated groundwater in the well and allowing additional groundwater flow into the well. Once inside the well, some of the VOCs in the contaminated groundwater are transferred from the water to air bubbles, which rise and are collected at the top of the well by vapor extraction.

B.1.5.2 *In situ*: Bioremediation

Co-Metabolic Processes

An emerging application involves the injection of water containing dissolved methane and oxygen into groundwater to enhance methanotrophic biological degradation.

Nitrate Enhancement

Nitrate is circulated throughout groundwater contamination zones as an alternative electron acceptor for biological oxidation or organic contaminants by microbes.

Oxygen Enhancement With Air Sparging

Air is injected under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of organic contaminants by naturally occurring microbes.

Oxygen Enhancement With Hydrogen Peroxide

A dilute solution of hydrogen peroxide is circulated throughout a contaminated groundwater zone to increase the oxygen content of groundwater and enhance the rate of aerobic biodegradation of organic contaminants by microbes.

B.1.5.3 *Ex Situ:* Physical/Chemical

Air Stripping

Air stripping is a mass transfer process whereby volatile contaminants are removed from liquids, such as groundwater, by forcing high-pressure air through the liquid. Air stripping is commonly performed on site using a packed tower that works on the principle of countercurrent flow. The contaminated water would flow downward through the packing while the air would flow upward and would be exhausted through the top. Other types of air strippers include the low profile tray and multi-cell air stripper. These units diffuse air through a chamber of flowing water to achieve the mass transfer process. Because volatile contaminants are transferred from the liquid phase to the gaseous phase and then vented from the air stripping unit, emission control devices may be required to first remove the contaminants from the airstream. To comply with applicable regulations, an emission controls device may be required. Air emission control devices include a vapor-phase granular activated carbon (GAC) and a catalytic oxidizer. It is not effective for vinyl chloride or inorganics and may require pH adjustment of H_2S, phenol, ammonia, and other organic acids or bases to reduce solubility and improve transfer to the gas phase. The influent may have to be pretreated to remove iron and magnesium present in the groundwater.

Steam Stripping

Steam stripping is used to remove VOCs from water or aqueous streams. The steam stripping technology is similar to the air stripping technology, except that steam stripping uses steam as the gas phase. Compounds with relatively low volatility or high water solubility are not readily airstrippable, but can often be removed with steam stripping. As with air stripping, the volatile contaminants would be transferred from the liquid phase to the vapor phase, leaving a treated bottom product of clean water, and a vapor that is condensed and collected. The condensed vapor product is a concentrated aqueous solution that may be treated further or recycled. However, noncondensing organics like vinyl chloride will be vented to the atmosphere. Therefore, a vapor phase treatment system like that proposed for the air stripping treatment would be required.

Cascade Aerator

Originally used as an effective means of oxygenating large flows of wastewater, this process option is also used for the removal of VOCs from groundwater. It is a simple and very low cost process option. The groundwater is pumped to the top of an inclined plane, where it cascades by gravity down a transversely corrugated surface. The resulting turbulence enhances the mass exchange of dissolved VOCs from the water to the gas phase. Desorption coefficients (overall mass transfer) are generally one order of magnitude larger than those reported for packed columns. Tests show rates greater than 99 percent are possible with reasonable treatment surface lengths and angles of inclination. One disadvantage was that the same tests showed cascade aeration was only partially effective for removing soluble chemicals with a Henry's law constant of less than 50 atmospheres.

Ultraviolet Oxidation

UV/oxidation treatment involves the use of ozone, or hydrogen peroxide and ultraviolet light to photo-oxidize organic contaminants. Groundwater would be pumped into holding tanks and hydrogen peroxide added to begin destruction of the organics. Ozone would be generated in the UV/oxidation tanks. Ultimately, the VOCs would be destroyed, resulting in carbon dioxide, water, and halide ions. Unreacted contaminants or partially oxidized residuals in the aqueous effluent may require additional treatment. During this process, the system would provide emission control for generated hydrogen chloride.

Chemical Oxidation/Reduction

In chemical oxidation and reduction technologies, chemical transformation of reactants occurs, and the contaminants are destroyed by oxidation or their toxicity is lowered by raising the oxidation state of one reactant while reducing that of another. Oxidation treatment could be used for benzene and most organics, phenols, cyanide, arsenic, iron, and manganese. Reduction treatment could be used for chromium (VI), lead, silver, and chlorinated organics such as polychlorinated biphenyl (PCBs). In some cases, undesirable by-products may be formed as a result of oxidation/reduction.

Liquid Phase Carbon Adsorption

GAC adsorption is a treatment process that is widely used, effective, and easily implemented for the treatment of a wide range of organic groundwater contaminants. Adsorption is a surface phenomenon in which soluble molecules from a solution are bonded onto a carbon surface. Once the carbon surface is saturated with contaminants, the carbon material is replaced, and the saturated carbon is regenerated or incinerated. The useful life of the carbon depends upon the specific contaminants, contaminant mass flow rate, and effluent contaminant concentrations. The useful life of the carbon could be extended by pretreatment of the groundwater before passing it through the carbon filters.

Resin Adsorption

Resin adsorption is used for the removal of organic contaminants from aqueous waste streams. Similar to carbon adsorption, organic molecules contacting the resin surface would be held on the surface by physical forces and subsequently removed during the resin regeneration cycle. The type of resin used would be tailored specifically for the COC.

Membrane Microfiltration (With or Without Precipitation)

The membrane microfiltration technology is an above-ground treatment system designed to remove solid particles from liquid wastes and from filter cakes typically ranging from 40 to 60% solids. This technology is best suited for treating contaminated groundwater with total dissolved solids of less than 5000 ppm and may be applied to heavy metals, landfill leachate, volatile organics, and oily wastes. A pilot demonstration has been conducted in which the system treated heavy metal contaminants in groundwater.

Ion Exchange

Ion exchange is a process that reversibly exchanges ions in solutions with ions retained on a reactive solid material called the ion exchange resin. Because the reaction is reversible, it is possible to regenerate the ion exchange resin. This process option is used mostly for metals and inorganics.

Reverse Osmosis

Reverse osmosis is a physicochemical process that involves flow from a dilute solution through a semipermeable membrane to a more concentrated solution. The application of pressure to the concentrated solution to overcome the osmotic pressure would force the net flow of water through the membrane toward the dilute phase. As the water flows through the membrane, the larger organic and inorganic compounds would be rejected. This process can reduce concentrations of dissolved organic and inorganic solids in groundwater, but extensive pretreatment is often required, and the equipment is subject to fouling and plugging. The resulting concentrated residuals would contain hazardous constituents.

Dechlorination

Dechlorination is a process in which chlorine is chemically removed from chlorinated organic compounds, such PCBs and dioxins. It is mainly used for dechlorination of transformer fluids. By-products include salts, polymers, and heavy metals.

B.1.5.4 *Ex Situ*: Thermal

Liquid Injection Incinerator

A liquid incineration system consist of a single or double refractory-lined combustion chamber and a series of atomizing nozzles. The liquid waste would be converted to a gas before combustion. Liquid injection incineration would be operated at high temperatures and used to destroy various types of pumpable waste or gas such as PCBs, solvents, polymer wastes, and pesticides.

B.1.5.5 *Ex Situ*: Biological

Bioreactors

On-site biological treatment processes use conventional, aboveground biological methods to remove organic contaminants from groundwater through microbial degradation. These conventional biological methods include aerobic and anaerobic processes. Aerobic biological treatment consists of activated sludge processes, rotating biological contactors, and trickling filters. The anaerobic process uses a digester. All processes are performed aboveground. The microorganisms in the aerobic and anaerobic processes would require both carbon and energy sources. The objective is for the contaminants present in the groundwater to provide these sources for sustained biological growth. If aerobic organisms are used in the treatment process, then an oxygen source would also be required. Treatability studies would be required to determine optimal conditions, and the microorganisms used in the treatment process would have to be acclimated. The sludge that accumulates within the biological process units would also requires disposal.

B.1.5.6 On-Site Pretreatment/Post-Treatment

Precipitation

Chemical precipitation/flocculation is a physicochemical process in which a dissolved constituent is transformed into an insoluble solid, facilitating its subsequent removal from the liquid phase by sedimentation or filtration. The process usually involves (1) adjustment of pH to shift the chemical equilibrium to a point that no longer favors solubility, (2) addition of a chemical precipitant, or (3) flocculation in which precipitate particles agglomerate into larger particles. The residuals may contain hazardous constituents and would require disposal according to RCRA and solid waste regulations.

Filtration

Filtration is a process whereby suspended solids are removed from solution by forcing the fluid through a porous medium. Filters are often preceded by sedimentation basins. The filter media is usually a granular material, such as sand, and would be contained within a tank equipped with an underdrain system. The liquid to be filtered would be drawn through the media and then removed through the underdrain while the filter media remained in place trapping particles. The media would be periodically flooded or backwashed to remove the trapped particles. The residuals may contain hazardous constituents and would require disposal according to RCRA and solid waste regulations.

B.1.5.7 On-Site Air Emissions/Off-Gas Treatment

Membrane Separation

This organic vapor/air separation technology involves the preferential transport of organic vapors through a nonporous gas separation membrane (a diffusion process analogous to putting hot oil on a piece of waxed paper).

Oxidation

Organic contaminants are destroyed in a high temperature 1,000°C (1,832°F) combustor. Trace organics in contaminated air streams are destroyed at lower temperatures, 450°C (842°F), than conventional combustion by passing the mixture through a catalyst.

Vapor Phase Carbon Adsorption

Off-gases are pumped through a series of canisters or columns containing activated carbon to which organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required.

B.1.6 Natural Attenuation

Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels. May take extended periods of time prior to significant reduction is evident, during which period, contaminant monitoring is typically performed.

B.1.7 Disposal

B.1.7.1 On-Site Disposal: Untreated Groundwater

Deep Well Injection

Under this option, a deep well for untreated liquid waste injection would be drilled and completed in a water-bearing, hydrogeologic formation hydraulically confined by overlying and underlying impermeable formations. The formation receiving the waste must be sufficiently thick, permeable, and extensive to prevent migration of the injected waste into adjacent formations or aquifers.

B.1.7.2 On-Site Disposal: Treated Groundwater

Shallow-Well Injection

Shallow-well injection consists of wells completed in the upper portion of the aquifer for the injection of treated groundwater. Shallow-well injection would recharge the surficial aquifer, which may enhance the efficiency of groundwater collection systems such as the pumping well system. An additional benefit is that a hydraulic barrier would be formed. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, would not be desirable to reinject the treated groundwater into the surficial aquifer.

Infiltration Gallery

An infiltration gallery consists of a trench designed to recharge the surficial aquifer. A trench would be excavated and the base backfilled with coarse sand or gravel to increase infiltration rates. A benefit of this technology is a hydraulic barrier that would be formed, which can redirect groundwater flow. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, it would not be desirable to discharge treated groundwater into the surficial aquifer.

Subsurface Irrigation

A subsurface irrigation system for the disposal of treated groundwater is designed and operated much like a conventional wastewater leachfield. Long lengths of perforated pipes would be installed in closely spaced, shallow trenches. The base of the trenches would be partially backfilled with gravel before the pipes were installed to increase infiltration rates. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, would not be desirable to discharge treated groundwater into the surficial aquifer.

Surface Irrigation

A surface irrigation system consists of a network of evenly spaced, high-volume spray guns spaced evenly to distribute treated groundwater over a large area of ground surface. The treated groundwater would infiltrate the ground surface and recharge the surficial aquifer. However, until the treatment system has been operating for at least one year and sufficient data regarding concentrations of the treated effluent have been collected, would not be desirable to discharge treated groundwater into the surficial aquifer.

B.1.7.3 Offsite Disposal

Off-Site Facility

Under this process option, contaminated groundwater would be containerized and transported to an approved off-site facility for disposal. Some pretreatment may first be required.

NPDES-Permitted Outfall

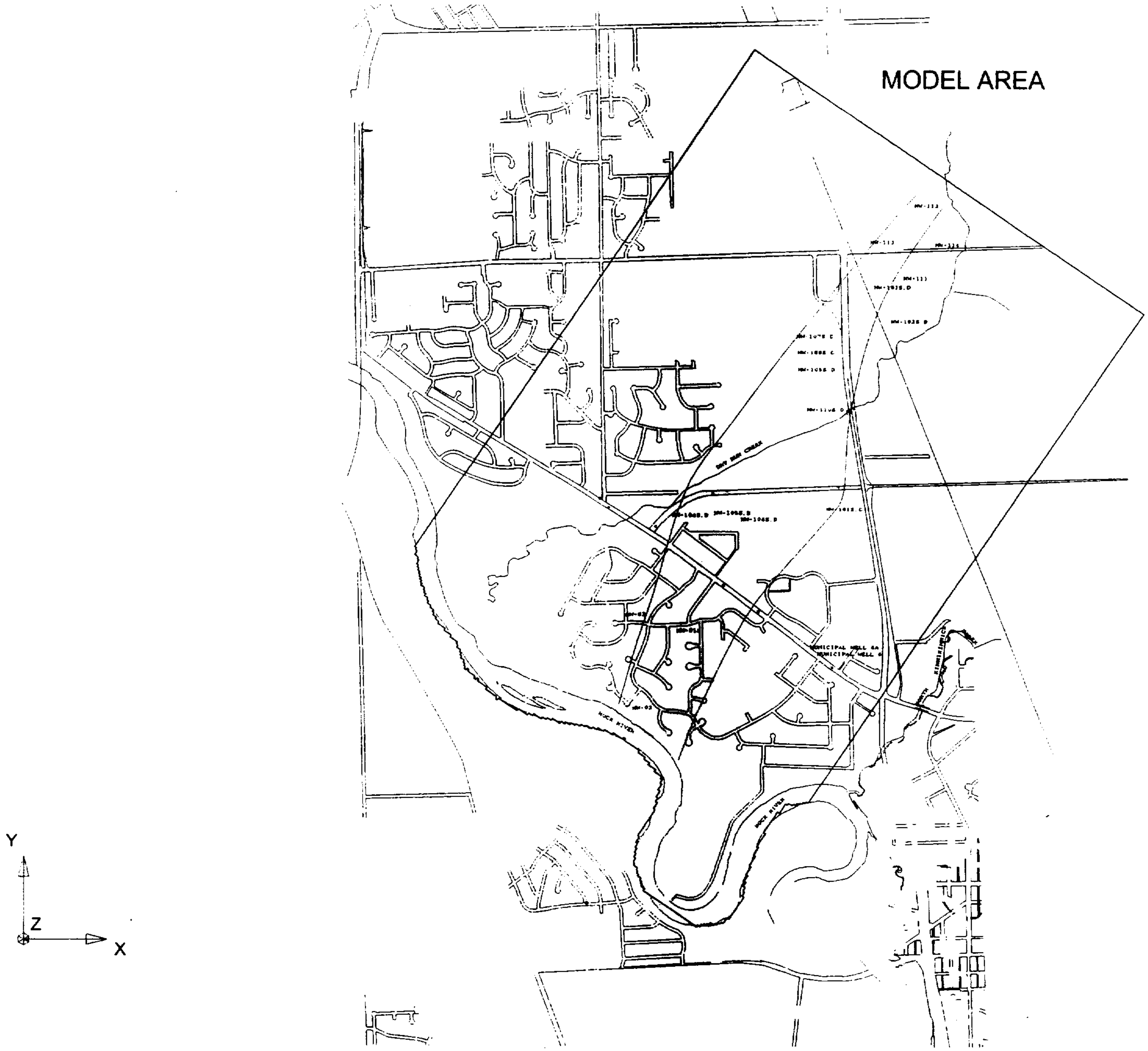
Under this process option, the NPDES permit would be modifed to include the discharge of treated groundwter from remediation activities.

B.1.8 Disposal of Treatment Residuals from Pretreatment Processes

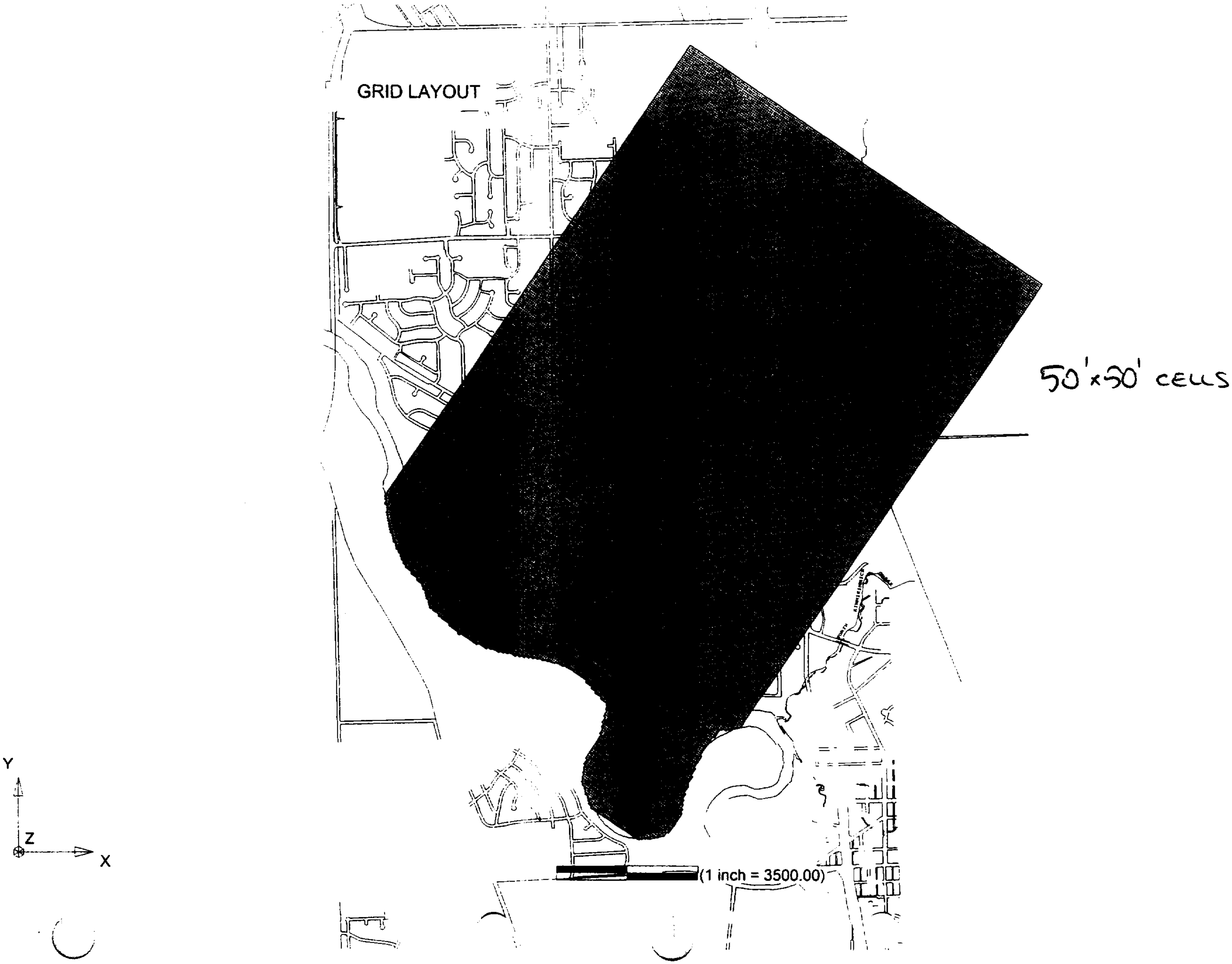
Off-Site Disposal

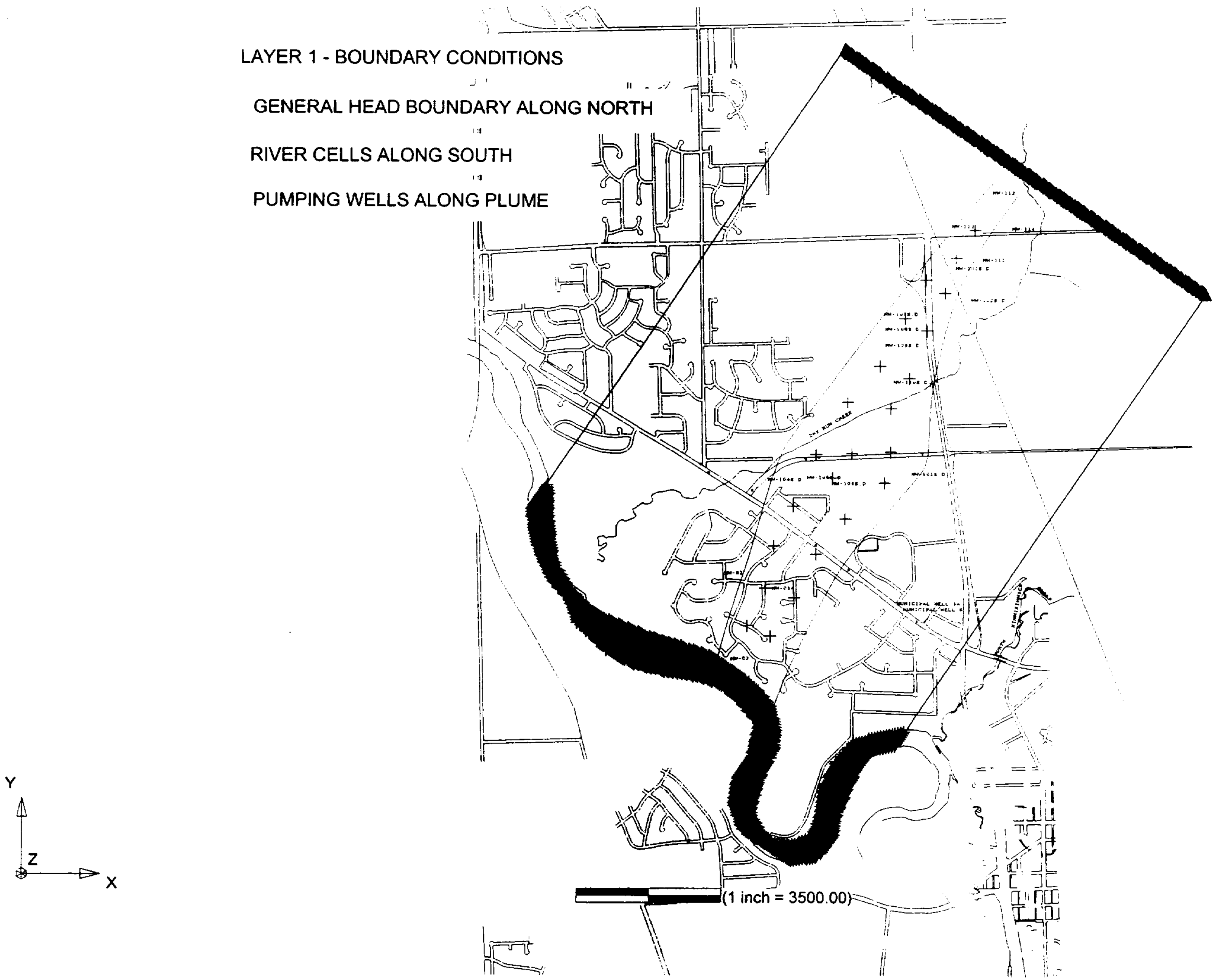
Disposal of the residuals associated with pretreatment process options could be accomplished at an approved, off-site facility. Certain expendable filter media, such as activated carbon and ion exchange resin, my be regenerated for reuse.

Appendix C



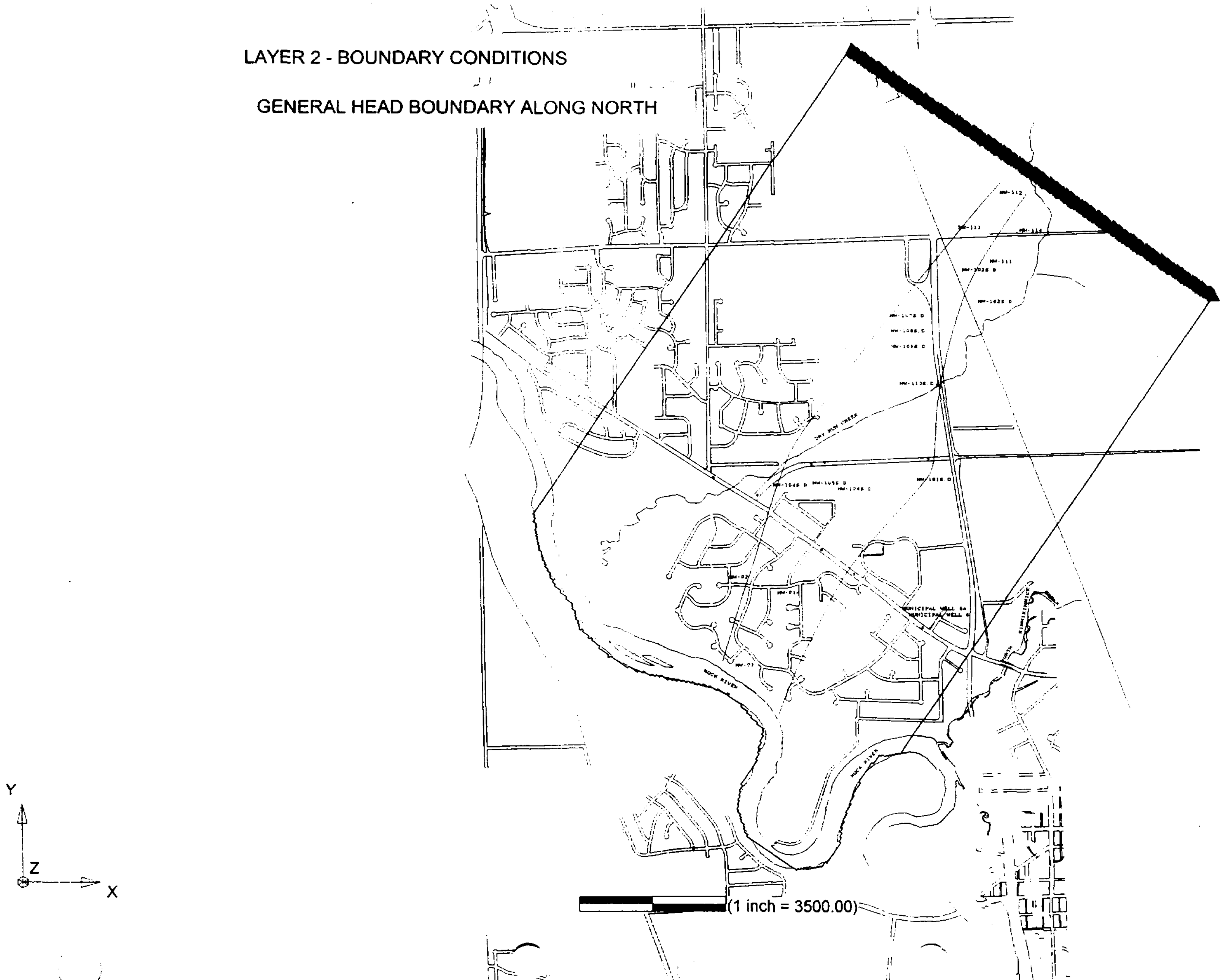
MODEL AREA
Y
Z
X


GRID LAYOUT
50'×50' CELLS
(1 inch = 3500.00)
Y
Z
X

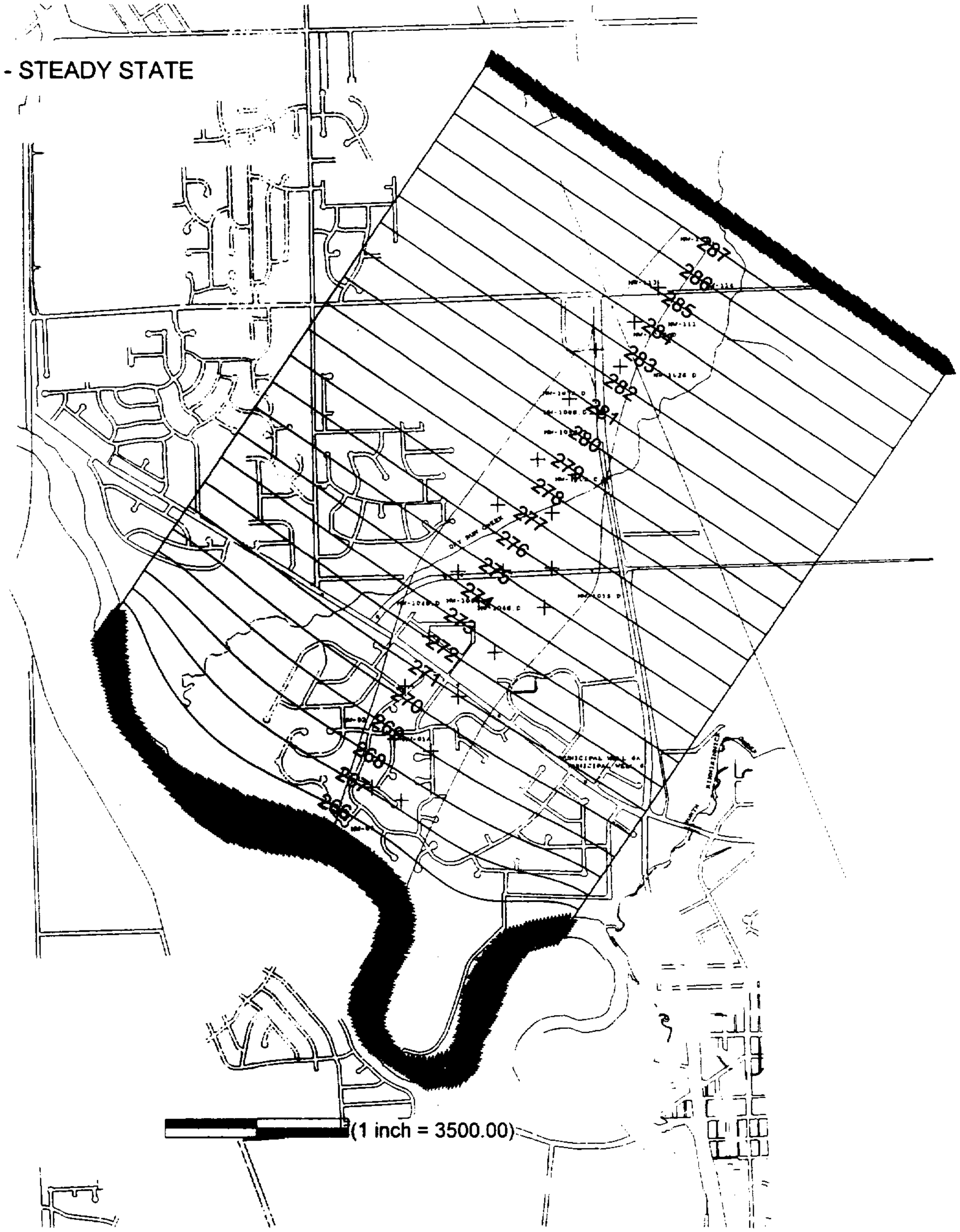

LAYER 1 - BOUNDARY CONDITIONS
GENERAL HEAD BOUNDARY ALONG NORTH
RIVER CELLS ALONG SOUTH
PUMPING WELLS ALONG PLUME
(1 inch = 3500.00)
Y
Z
X

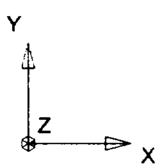
LAYER 2 - BOUNDARY CONDITIONS

GENERAL HEAD BOUNDARY ALONG NORTH

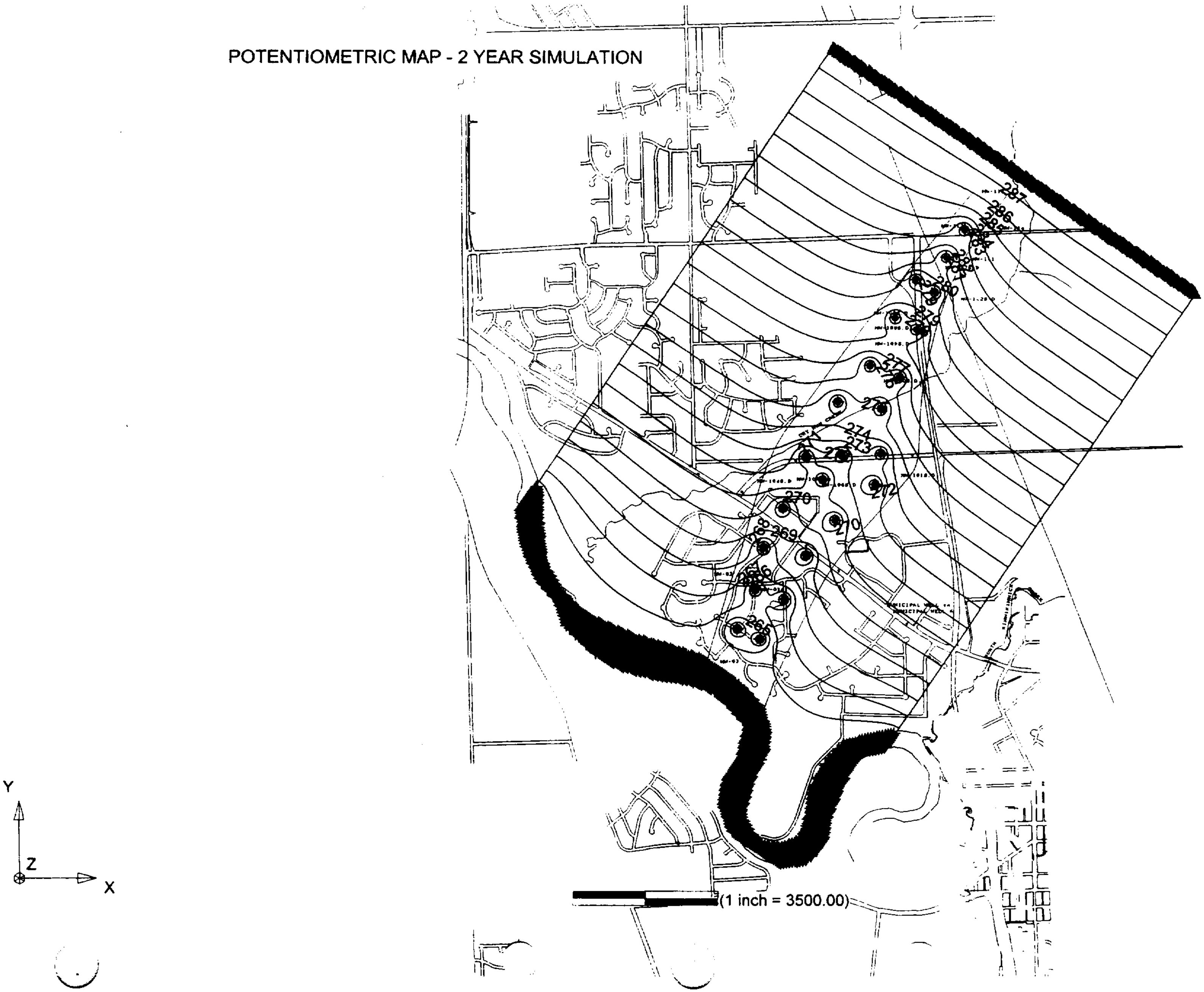


POTENTIOMETRIC MAP - STEADY STATE

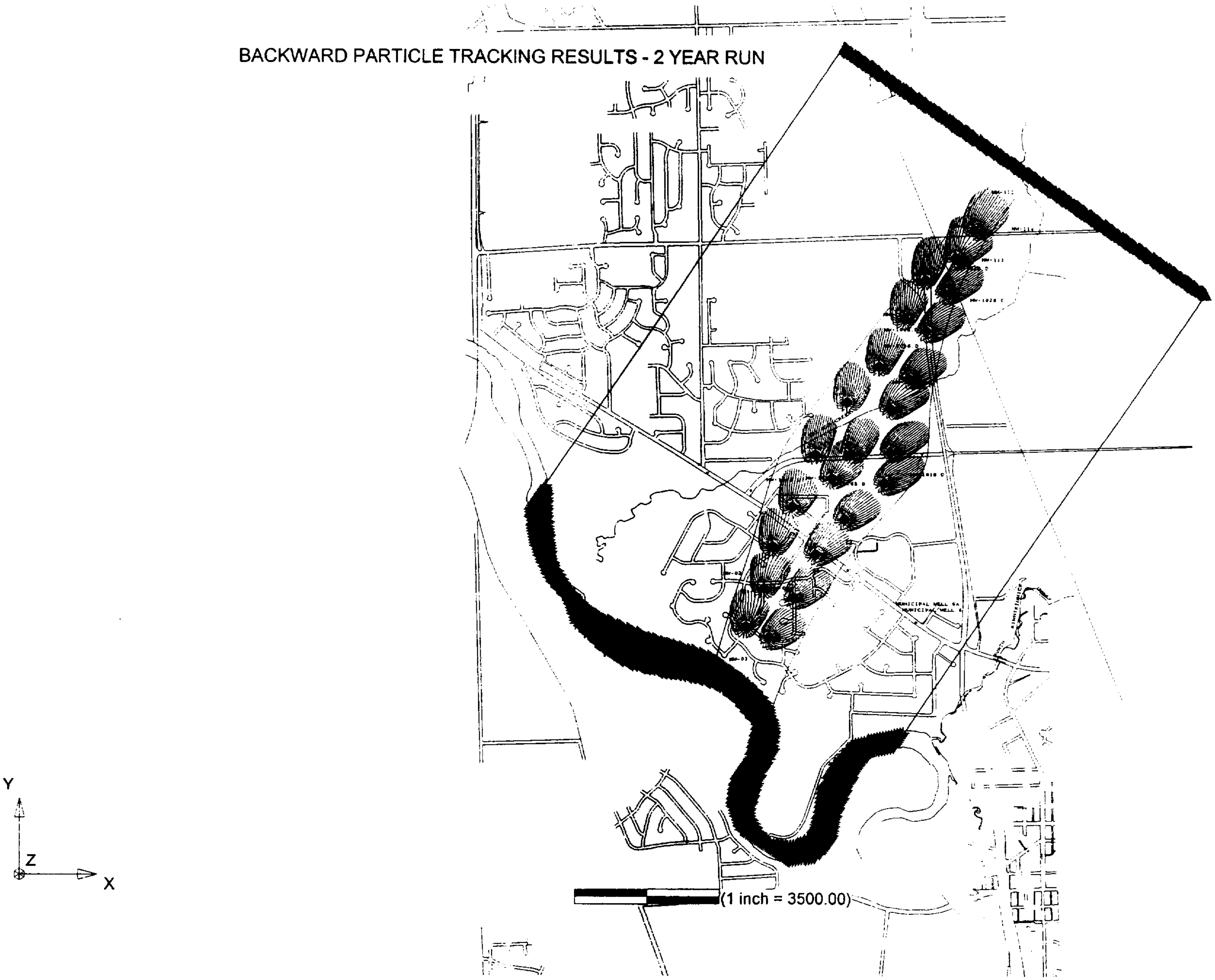




POTENTIOMETRIC MAP - 2 YEAR SIMULATION



BACKWARD PARTICLE TRACKING RESULTS - 2 YEAR RUN

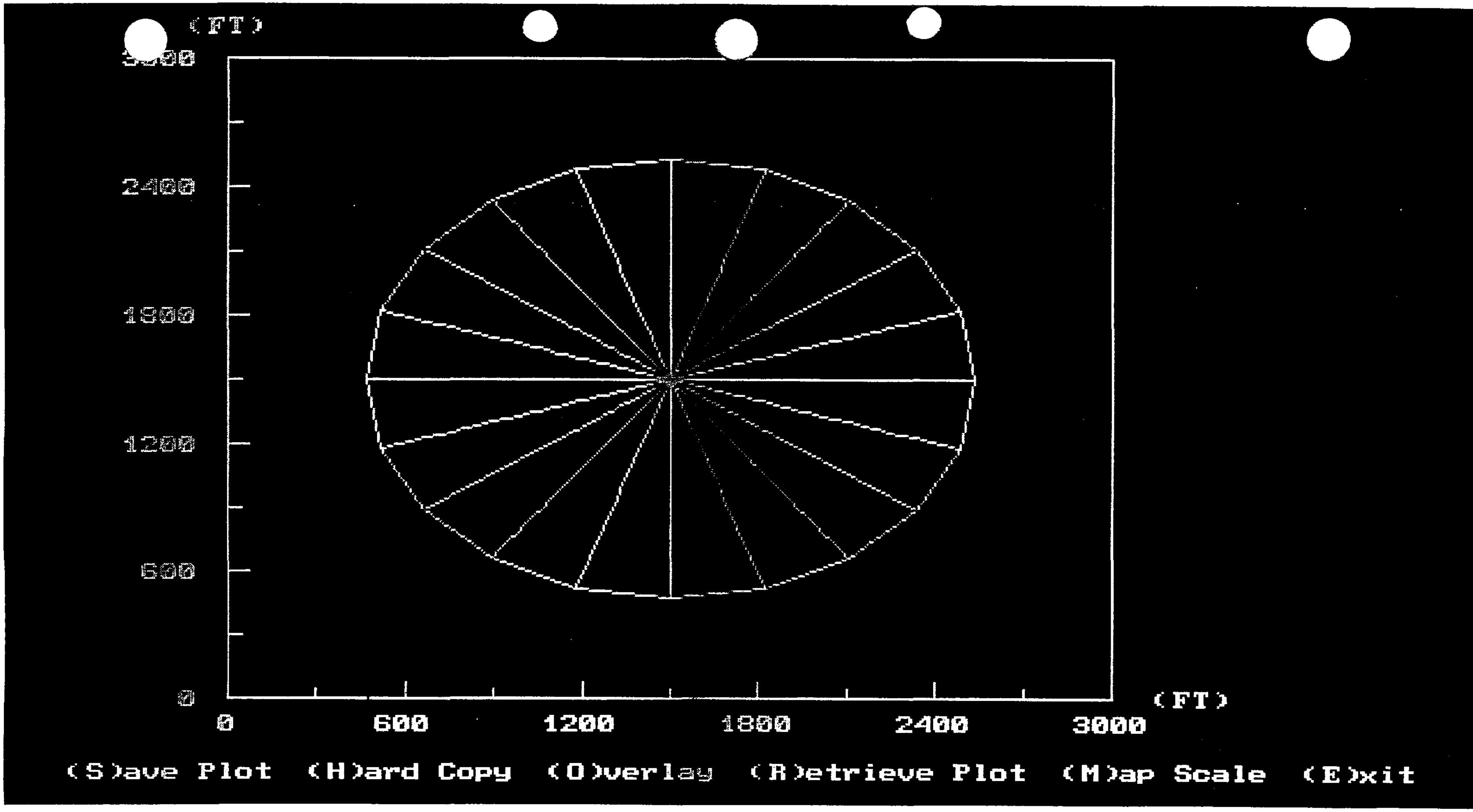


WATER BUDGET FOR THE STEADY STATE SIMULATION

```
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  1 IN STRESS PERIOD  1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                   IN:
          ---                                   ---
       CONSTANT HEAD =     3314246.0000         CONSTANT HEAD =    3314246.0000
               WELLS =           0.0000                 WELLS =          0.0000

            TOTAL IN =     3314246.0000              TOTAL IN =    3314246.0000

         OUT:                                  OUT:
         ----                                  ----
       CONSTANT HEAD =     3314246.0000         CONSTANT HEAD =    3314246.0000
               WELLS =           0.0000                 WELLS =          0.0000

           TOTAL OUT =     3314246.0000             TOTAL OUT =    3314246.0000

            IN - OUT =           0.0000              IN - OUT =          0.0000

 PERCENT DISCREPANCY =           0.00     PERCENT DISCREPANCY =          0.00



          TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                    SECONDS     MINUTES      HOURS       DAYS        YEARS
                    -----------------------------------------------------------
   TIME STEP LENGTH  86400.      1440.0      24.000      1.0000     2.73785E-03
 STRESS PERIOD TIME  86400.      1440.0      24.000      1.0000     2.73785E-03
         TOTAL TIME  86400.      1440.0      24.000      1.0000     2.73785E-03
```

WATER BUDGET AT THE END OF TWO YEAR SIMULATION

```
 VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP  1 IN STRESS PERIOD  1
 ------------------------------------------------------------------------------

    CUMULATIVE VOLUMES      L**3       RATES FOR THIS TIME STEP      L**3/T
    ------------------                 ------------------------

          IN:                                       IN:
          ---                                       ---
            STORAGE =  1663069568.0000              STORAGE =     2278177.5000
      CONSTANT HEAD =          0.0000         CONSTANT HEAD =           0.0000
              WELLS =          0.0000                 WELLS =           0.0000
      RIVER LEAKAGE =          0.0000         RIVER LEAKAGE =           0.0000
    HEAD DEP BOUNDS =   221329568.0000      HEAD DEP BOUNDS =      303191.1875

           TOTAL IN =  1884399104.0000             TOTAL IN =     2581368.7500

         OUT:                                      OUT:
         ----                                      ----
            STORAGE =    44355492.0000              STORAGE =       60760.9453
      CONSTANT HEAD =          0.0000         CONSTANT HEAD =           0.0000
              WELLS =  1679000064.0000                WELLS =     2300000.0000
      RIVER LEAKAGE =   161607072.0000        RIVER LEAKAGE =      221379.5469
    HEAD DEP BOUNDS =          0.0000       HEAD DEP BOUNDS =           0.0000

          TOTAL OUT =  1884962688.0000            TOTAL OUT =     2582140.5000

           IN - OUT =     -563584.0000             IN - OUT =        -771.7500

 PERCENT DISCREPANCY =          -0.03   PERCENT DISCREPANCY =          -0.03




         TIME SUMMARY AT END OF TIME STEP  1 IN STRESS PERIOD  1
                    SECONDS     MINUTES      HOURS       DAYS        YEARS
                    -----------------------------------------------------------
   TIME STEP LENGTH 6.30720E+07 1.05120E+06  17520.      730.00      1.9986
 STRESS PERIOD TIME 6.30720E+07 1.05120E+06  17520.      730.00      1.9986
         TOTAL TIME 6.30720E+07 1.05120E+06  17520.      730.00      1.9986
```

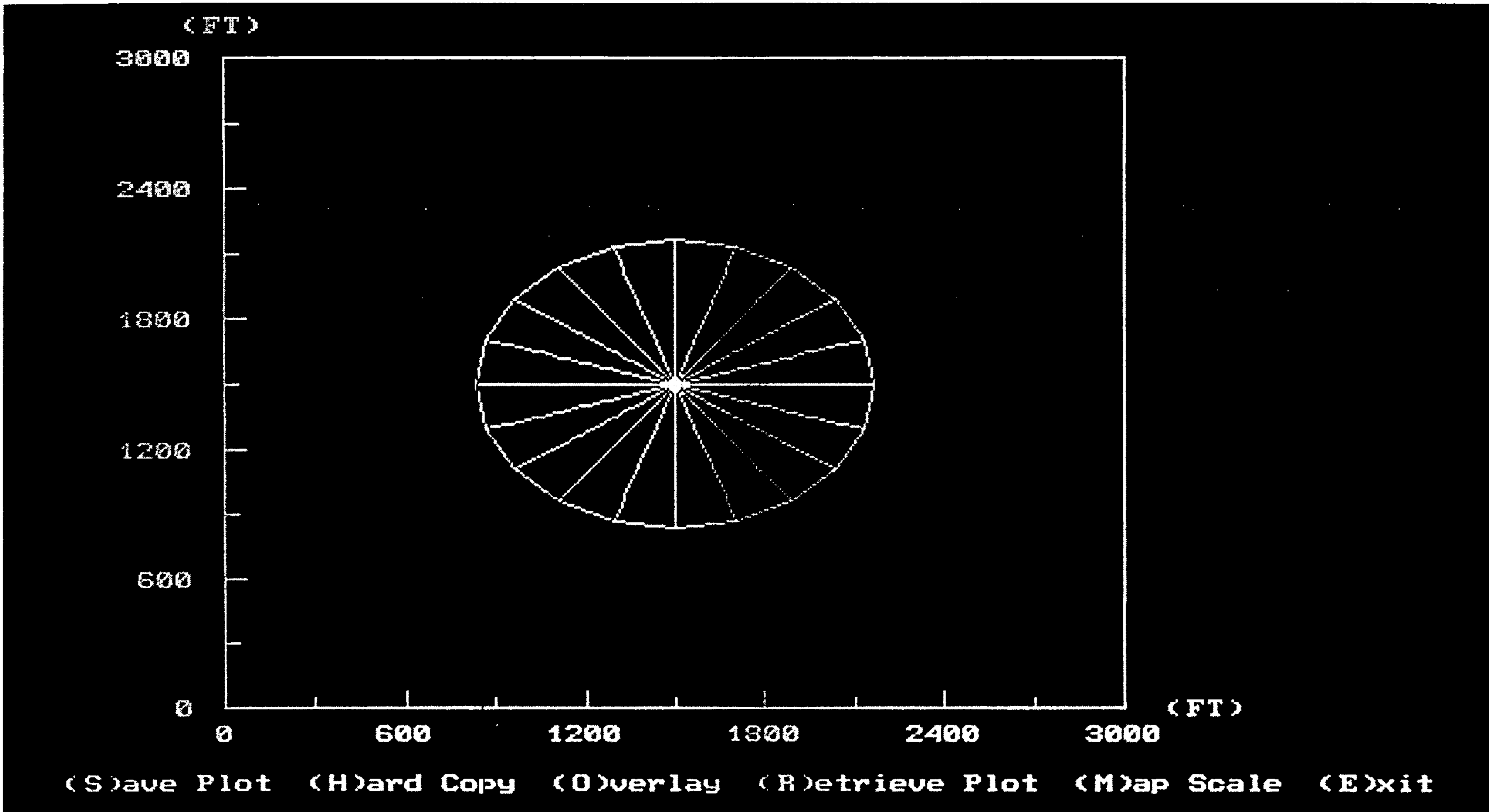


WHPA OUTPUT

→ Capture zone → Well located at (1500,1500) ; $T = 7539\ ft^2/d$; $Q = 500\ gpm = 96257\ ft^3/d$.

→ Run time = 730 days ; Aquifer thickness = 70 ft.

radius of influence ~ 1,000 ft



WHPA output

$T = 18309\ ft^2/d$ $Q = 500\ gpm = 96257\ ft^3/d$

Run time = 730 d Aquifer thickness = 170 ft.

radius of influence ~ 650 ft.

Appendix D

SHEET 1 of 2

CLIENT/SUBJECT U.S. EPA- Evergreen Manor W.O. NO. 20064.139.100

TASK DESCRIPTION Pore Vol. Calculation of TCE for FS TASK NO. 1220

PREPARED BY YH DEPT 1154 DATE 7/21/03

MATH CHECK BY ______ DEPT ______ DATE ______

METHOD REV. BY ______ DEPT ______ DATE ______

APPROVED BY ______ DEPT ______ DATE ______

<TCE>

Assumptions

- Initial Concentration (C_0) = 7.2 μg/L (2002 MW-03 data)
- Target Concentration (C) = 5.0 μg/L

$$\frac{C}{C_0} = \frac{5}{7.2} = 0.694$$

- Adsorption Coefficent (K_{oc}) = 95.5 (L/kg) for TCE (From 2000 RI, WESTON 2001
- Porosity (n) = 30% or 0.3
- Bulk Density (ρ_b) = 1.8 kg/L (Illinois Administrati code for sand
- Fraction of Organic Carbon (f_{oc}) = 0.0006

Retardation Factor (R) can be obtained by the following equation:

$$R = 1 + \frac{\rho_b}{n} \times f_{oc} \times K_{oc}$$

$$= 1 + \frac{1.8\ kg/L}{0.3} \times 0.0006 \times 95.5\ (L/kg)$$

$$= 1.3438$$

Pore Volume (PV) can be calculated by the following equation:

$$PV = PV_{R=1} \times R$$ (Newell et. al., 1994*)

CLIENT/SUBJECT U.S.EPA - Evergreen Manor W.O. NO. 20064.139.100

TASK DESCRIPTION Pore volume Calculation - TCE TASK NO. 1220

PREPARED BY YH DEPT 1154 DATE 7/21/03

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

<TCE> (continued) where $PV_{R=1}$ = Pore volumes required for the case where R = 1 or no retardation.

From $\frac{C}{C_0} = 0.694$, $PV_{R=1} = 2.5$

(Newell et. al., 1994*)

From the earlier calculation, R = 1.3438.

Therefore $PV = 2.5 \times 1.3438$

$= 3.36$ Pore volumes

* C.J. Newell, R.L. Bowers, and H.S. Rifai, 1994
"Impact of Non-Aqueous Phase Liquids (NAPLs) on Groundwater Remediation."
Summer National AICHE Meeting August 16, 1994
Symposium 23, "Multimedia Pollutant Transport Models."

WESTON SOLUTIONS

SHEET 1 of 1

CLIENT/SUBJECT U.S. EPA - Evergreen Manor W.O. NO. 20064.139.100

TASK DESCRIPTION Pore vol. Calculation of PCE for FS TASK NO. 1220

PREPARED BY YH DEPT 1154 DATE 7/21/03

MATH CHECK BY ______ DEPT ______ DATE ______

METHOD REV. BY ______ DEPT ______ DATE ______

APPROVED BY ______ DEPT ______ DATE ______

<PCE>

Assumptions :

- Initial concentration $(C_o) = 5.9\,\mu g/L$ (2002 MW-103S da

- Target Concentration $(C) = 5\,\mu g/L$

$$\frac{C}{C_o} = \frac{5}{5.9} = 0.847$$

- $K_{oc} = 269.19$ (L/kg) for PCE (From 2000 RI, WESTON 20

- $n = 30\%$ or 0.3

- $\rho_b = 1.8$ kg/L (from IAC)

- $f_{oc} = 0.0006$

$$R = 1 + \frac{\rho_b}{n} + f_{oc} \times K_{oc}$$

$$= 1 + \frac{1.8\,kg/L}{0.3} \times 0.0006 \times 269.19\,(L/kg)$$

$$= 1.969$$

$PV = PV_{R=1} \times R$ (Newell et. al., 1994*)

where $PV_{R=1} = 2$ at $\frac{C}{C_o} = 0.847$

(Newell et. al., 1994)

$PV = 2 \times 1.969 = 3.938 \approx 4$ pore volumes

RFW 10-05-003/A-5/85

Appendix E

Appendix E
VOM Caluculation
Evergreen Manor Site
Roscoe, Illinois

Assumed flowrate =	1500	gallons per minute
=	2980152000	liters per year
1 ug =	1.1023E-12	ton

Constituent	Maximum Concentration[1], ug/L	Contaminant mass contained in groundwater pumped over 1 year, ug	Contaminant mass contained in groundwater pumped over 1 year, tons
PCE	9	26,821,368,000	2.96E-02
TCE	7	21,457,094,400	2.37E-02
		Total mass[2], tons/year=	**0.053**
		Total mass[2], lbs/year =	**106.43**

NOTES:
1 - Based on RI and FS sampling results.
2 - Assumes 100% stripper efficiency.
3- Assumes 100% VOC removal

Appendix E
VOM Caluculation
Evergreen Manor Site
Roscoe, Illinois
(Continued)

Assumed flowrate =	1500	gallons per minute
=	2,980,152,000	liters per year
1 ug =	1.1023E-12	ton

Constituent	Average Concentration[1], ug/L	Contaminant mass contained in groundwater pumped over 1 year, ug	Contaminant mass contained in groundwater pumped over 1 year, tons
PCE	9.0	26,821,368,000	2.96E-02
TCE	7.2	21,457,094,400	2.37E-02
		Total mass[2], tons/year=	**0.053**
		Total mass[2], lbs/year =	**106.43**

NOTES:
1 - Based on RI and FS sampling results.
2 - Assumes 100% stripper efficiency.
3- Assumes 100% VOC removal

Appendix F

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
DIRECT COSTS						
SITE CHARACTERIZATION AND INITIAL INVESTIGATION						
VERTICAL PROFILE SAMPLING						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$398,094	$398,094		Cost includes subcontractor labor, mobilization, decon, water sampling, boring abandonment, and drilling. Profiling will be done at 40 locations to a depth of 135 feet. Based on 10 samples per location.
OVERSIGHT OF WORK						
Labor	1280	hour	$80	$102,400		Based on 2 people for 64 days (10 hours per day).
Per Diem	128	man days	$85	$10,880		Based on 2 people for 64 days.
Equipment	1	lump sum	$8,500	$8,500		Cost includes rental of equipment and expendable supplies.
Rental Vehicle	64	day	$80	$5,120		
ANALYTICAL						
VOC Analysis (water)	530	sample	$90	$47,700		Based on 400 investigative samples, 40 duplicates, 40 equipment blank, and 50 trip blanks
Shipping	50	shipment	$70	$3,500		
					$576,194	
PIEZOMETER INSTALLATION						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$40,471	$40,471		Cost includes subcontractor labor, mobilization, decon, well materials, and drilling. 10 piezometers will be installed to 50';1 piezometer will be installed to 100' (50% of wells necessary of Alternative 3 was assumed).
OVERSIGHT OF WORK						
Labor	80	hour	$80	$6,400		Based on 2 people for 4 days (10 hours per day).
Per Diem	8	man days	$85	$680		Based on 2 people for 4 days.
Equipment	1	lump sum	$1,500	$1,500		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	4	day	$80	$320		
					$49,371	
MONITOR WELL INSTALLATION						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$43,265	$43,265		Cost includes subcontractor labor, mobilization, decon, well materials, and drilling. Based on 3 wells to be installed to 50';3 wells to be installed to 100'.
OVERSIGHT OF WORK						
Labor	120	hour	$80	$9,600		Based on 2 people for 6 days (10 hours per day).
Per Diem	12	man days	$85	$1,020		Based on 2 people for 6 days.
Equipment	1	lump sum	$300	$300		Cost includes equipment rental and expendable supplies.
Rental Vehicle	6	day	$80	$480		
					$54,665	

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
DEVELOPMENT OF NEWLY INSTALLED WELLS						
Labor	40	hour	$80	$3,200		Based on 3 wells per day (10 hours per day); total of 6 wells
Per Diem	4	man days	$85	$340		Based on 2 people for 2 days
Equipment	1	lump sum	$600	$600		Include equipment rental and expendable supplies
Rental Vehicle	2	day	$80	$160		
					$4,300	
BASELINE RESIDENTIAL WELL SAMPLING						
Pre-Sampling Labor	160	hour	$40	$6,400		Obtaining access agreements to sample at a residence, based on 10 access agreements signed per day (10 hours per day) for total of 73 wells (10 wells part of long term monitoring program)
Labor	70	hour	$80	$5,600		Based on 10 wells per day (10 hours per day) for 2 people (10 hours per day) for 7 days
Per Diem	14	man days	$85	$1,190		
Rental Vehicle	7	days	$80	$560		
Analytical						
VOC analysis (water)	84	sample	$90	$7,560		Based on 63 investigative samples, 7 duplicates, 7 trip blanks, and 7 equipment blanks
Shipping	7	shipment	$70	$490		
					$21,800	
SOIL VAPOR SAMPLING						
GEOPROBE SUBCONTRACTOR	1	lump sum	$21,077	$21,077		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 50 locations with 3 borings at each location (8', 20', and 30').
OVERSIGHT OF WORK						
Labor	300	hour	$80	$24,000		Based on 2 people for 15 days (10 hours per day)
Per Diem	30	man days	$85	$2,550		Based on 2 people for 15 days
Equipment	1	lump sum	$3,350	$3,350		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	15	day	$80	$1,200		
ANALYTICAL						
VOC Analysis (air)	195	sample	$600	$117,000		Based on 150 investigative samples, 15 trip blanks, 15 equipment blanks, 15 duplicate
Shipping	30	shipment	$70	$2,100		
					$171,277	

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
SHALLOW GROUNDWATER CHARACTERIZATION						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$56,120	$56,120		Cost includes labor, mobilization, decon, well materials, and drilling. 50 locations will be investigated. Each boring will be completed to 45', with groundwater samples being collected from 35' to 40' and 40' to 45'.
OVERSIGHT OF WORK						
Labor	300	hour	$80	$24,000		Based on 2 people for 15 days (10 hours per day)
Per Diem	30	man days	$85	$2,550		Based on 2 people for 15 days.
Equipment	1	lump sum	$350	$350		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	15	day	$80	$1,200		
ANALYTICAL						
VOC analysis (water)	130	sample	$90	$11,700		Based on 100 investigative samples, 10 trip blanks, 10 equipment blanks, 10 duplicate
Shipping	15	shipment	$70	$1,050		
					$96,970	
ADDITIONAL SOIL SAMPLING						
GEOPROBE SUBCONTRACTOR	1	lump sum	$1,878	$1,878		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 10 borings to be drilled to 10ft.
OVERSIGHT OF WORK						
Labor	24	hour	$80	$1,920		Based on 2 people for 1 day (12 hour per day)
Per Diem	2	man days	$85	$170		Based on 2 people for 1 day.
Equipment	1	lump sum	$200	$200		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	1	day	$80	$80		
ANALYTICAL						
VOC Analysis (soil)	65	sample	$157	$10,205		Based on 5 soil samples per boring, 5 trip blanks, 5 equipment blanks, 5 duplicates
Shipping	1	shipment	$70	$70		
					$14,523	
SEPTIC SYSTEM CHARACTERIZATION						
SUBCONTRACTOR WORK						
Geoprobe Subcontractor	1	lump sum	$7,960	$7,960		Cost includes subcontractor labor, mobilization, decon, and materials. For soil gas, 10 homes are assumed to be investigated with 3 samples per home to the depth of 15 feet. For soil sampling, 10 homes were assumed to be investigated with 3 samples per home to the depth of 10 feet.
Rotosonic Subcontractor	1	lump sum	$11,224	$11,224		Cost includes labor, mobilization, decon, well materials, and drilling. 10 homes were assumed to be investigated. It was assumed that one boring will be completed at each home to the depth of 45 feet. Groundwater samples to be collected from 35 to 40 and 40 to 45 feet bgs.
OVERSIGHT OF WORK						
Labor	100	hour	$80	$8,000		Based on 2 people for 5 days (10 hours per day).
Per Diem	10	man days	$85	$850		Based on 2 people for 5 days.
Equipment	1	lump sum	$1,250	$1,250		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	5	day	$80	$400		
ANALYTICAL						
VOC analysis (soil)	39	sample	$157	$6,123		Based on 30 investigative samples, 3 equipment blank, 3 trip blank, 3 duplicate samples
VOC analysis (water)	27	sample	$90	$2,430		Based on 20 investigative samples, 2 equipment blank, 3 trip blank, 2 duplicate samples
VOC analysis (air)	36	sample	$600	$21,600		Based on 30 investigative samples, 3 equipment blank, 3 trip blank
Shipping	14	shipment	$70	$980		Based on 14 packages
					$60,817	

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
PUMP AND TREAT						
MOBILIZATION/DEMOBILIZATION	1	Lump Sum	$20,000	$20,000		Mob/Demob of groundwater system equipment.
					$20,000	
SITE PREPARATION						
Site Preparation	1	Lump Sum	$40,000	$40,000		Includes office trailer, furnishings, telephone, generator, sanitary facilities, and clearing and grubbing
Land acquisition	1	Lump Sum	$75,000	$75,000		Include 3 1/4-acre parcels for treatment building.
Easements	1	Lump Sum	$35,000	$35,000		
					$150,000	
INSTALLATION OF PUMP AND TREAT SYSTEM						
Predesign Pump Test	1	Lump Sum	$25,000	$25,000		
Extraction Wells	23	Wells	$6,500	$149,500		4-inch diameter, stainless steel, 100-ft deep each @$40/ft.
Groundwater Pumps	23	Lump Sum	$2,500	$57,500		500 gpm well pumps
8-inch Transfer Piping	14,300	Linear Feet	$26	$371,800		8-inch diameter, Installed. Includes fittings. Influent and effluent piping.
10-inch Transfer Piping	5,200	Linear Feet	$35	$182,000		10-inch diameter, Installed. Includes fittings. Influent and effluent piping.
12-inch Transfer Piping	4,000	Linear Feet	$44	$176,000		12-inch diameter, Installed. Includes fittings. Influent and effluent piping.
16-inch Transfer Piping	3,400	Linear Feet	$54	$183,600		16-inch diameter, Installed. Includes fittings. Influent and effluent piping.
18-inch Transfer Piping	4,200	Linear Feet	$70	$294,000		18-inch diameter, Installed. Includes fittings. Influent and effluent piping.
Treatment Building	25,200	Square Feet	$120	$3,024,000		2 120-ft by 70-ft buildings on slab foundation.
Treatment Building Foundation	25,200	Square Feet	$20	$504,000		8-inch thick, reinforced concrete.
Electrical	1	Lump Sum	$100,000	$100,000		Includes equipment and installation
Tray Stripper	23	Lump Sum	$65,000	$1,495,000		500 gpm design flow, stainless steel. Skid-mounted, 4-tray. Includes control package, feed pump, discharge pump.
Instrumentation	23	Lump Sum	$16,700	$384,100		
River/Creek Outfalls	3	Lump Sum	$15,000	$45,000		
Bag filter	23	Lump Sum	$1,000	$23,000		
Startup Sampling						
Air samples at Stack	6	Samples	$700	$4,200		
Influent/Effluent Water Samples	80	Samples	$150	$12,000		Analysis of VOCs. Includes shipping.
					$7,030,700	
DIRECT COST SUBTOTAL					$8,251,000	
INDIRECT COSTS						
ENGINEERING/DESIGN/INVESTIGATION						
Engineering and Design	1	-	$412,550	$412,550		5% capital costs
					$412,600	
CONTRACTOR PROCUREMENT	1	Lump Sum	$10,000	$10,000		
					$10,000	
BONDS AND INSURANCE	1	Lump Sum	$660,080	$660,080		8% capital costs
REPORT WRITING	1	Lump Sum	$66,000	$66,000		
					$66,000	
ADDITIONAL CHARACTERIZATION						
HOME OFFICE LABOR						
Project Planning	1	Lump Sum		$22,000		
					$22,000	
					$660,100	
CONSTRUCTION MANAGEMENT						
Project Manager	512	HR	$100	$51,200		8 hours/week for 64 weeks.
Resident Engineer	3,200	HR	$80	$256,000		One engineer for 64 weeks @ 50 hr/wk.
Per Diem (One Engineer)	320	DAY	$85	$27,200		
Car Rental	320	DAY	$80	$25,600		
H&S and Sampling Equipment	320	DAY	$1,000	$320,000		
Admin/Office Support	-	-	-	$25,600		10% of construction management labor.
Post-Construction Documentation and Certification	1	Lump Sum	$20,000	$20,000		
Site Security	64	WK	$2,000	$128,000		
					$853,600	
INDIRECT COST SUBTOTAL					$2,024,000	

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
ANNUAL OPERATIONS AND MAINTENANCE (O&M) COSTS						
MONITORING WELL SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-5						
Labor	480	hour	$80	$38,400		Based on 3 wells per day (10 hours per day) per sampling event. 16 wells are assumed to be sampled.
Per Diem	48	man days	$85	$4,080		
Equipment	4	lump sum	$1,500	$6,000		Includes equipment rental and expendable supplies.
Rental Vehicle	24	day	$80	$1,920		
ANALYTICAL						
VOC Analysis (water)	104	sample	$90	$9,360		Based on 16 investigative samples, 2 duplicates, 6 trip blanks, and 2 equipment blanks per sampling event.
Shipping	24	shipment	$70	$1,680		
Reporting	4	each	$11,000	$44,000		
					$105,400	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-5					$105,400	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-5					$132,000	
SEMIANNUAL MONITORING FOR YEARS 6-7						
Labor	240	hour	$80	$19,200		Based on 3 wells per day (10 hours per day) per sampling event. 16 wells are assumed to be sampled.
Per Diem	24	man days	$85	$2,040		
Equipment	2	lump sum	$1,500	$3,000		Includes equipment rental and expendable supplies.
Rental Vehicle	12	day	$80	$960		
ANALYTICAL						
VOC Analysis (water)	52	sample	$90	$4,680		Based on 16 investigative samples, 2 duplicates, 6 trip blanks, and 2 equipment blanks per sampling event.
Shipping	12	shipment	$70	$840		
Reporting	2	each	$11,000	$22,000		
					$52,700	
ANNUAL O&M COST SUBTOTAL FOR YEARS 6-7					$52,700	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEAR 6-7					$66,000	
ANNUAL MONITORING FOR YEARS 8						
Labor	120	hour	$80	$9,600		Based on 3 wells per day (10 hours per day) per sampling event. 16 wells are assumed to be sampled.
Per Diem	12	man days	$85	$1,020		
Equipment	1	lump sum	$1,500	$1,500		Includes equipment rental and expendable supplies.
Rental Vehicle	6	day	$80	$480		
ANALYTICAL						
VOC Analysis (water)	26	sample	$90	$2,340		Based on 16 investigative samples, 2 duplicates, 6 trip blanks, and 2 equipment blanks per sampling event.
Shipping	6	shipment	$70	$420		
Reporting	1	each	$11,000	$11,000		
					$26,400	
ANNUAL O&M COST SUBTOTAL FOR YEAR 8					$26,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEAR 8					$33,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$646,000	Assumes an interest factor of 7%

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
RESIDENTIAL WELL SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-5						
Labor	80	hour	$80	$6,400		Based on 10 wells per day (10 hours per day), based on 2 people sampling team per sampling event
Per Diem	8	man days	$85	$680		Based on 2 people for one day per sampling event
Rental Vehicle	4	day	$80	$320		
ANALYTICAL						
VOC Analysis (water)	52	sample	$90	$4,680		Based on 10 investigative samples, 1 duplicate, 1 trip blank, and 1 equipment blank per sampling event
Shipping	4	shipment	$70	$280		
Reporting	4	each	$11,000	$44,000		
					$56,400	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-5					$56,400	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-5					$71,000	
SEMIANNUAL MONITORING FOR YEARS 6-7						
Labor	40	hour	$80	$3,200		Based on 10 wells per day (10 hours per day), based on 2 people sampling team per sampling event
Per Diem	4	man days	$85	$340		Based on 2 people for one day per sampling event
Rental Vehicle	2	day	$80	$160		
ANALYTICAL						
VOC Analysis (water)	26	sample	$90	$2,340		Based on 10 investigative samples, 1 duplicate, 1 trip blank, and 1 equipment blank per sampling event
Shipping	2	shipment	$70	$140		
Reporting	2	each	$11,000	$22,000		
					$28,200	
ANNUAL O&M COST SUBTOTAL FOR YEARS 6-7					$28,200	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEAR 6-7					$35,000	
ANNUAL MONITORING FOR YEAR 8						
Labor	20	hour	$80	$1,600		Based on 10 wells per day (10 hours per day), based on 2 people sampling team per sampling event
Per Diem	2	man days	$85	$170		Based on 2 people for one day per sampling event
Rental Vehicle	1	day	$80	$80		
ANALYTICAL						
VOC Analysis (water)	13	sample	$90	$1,170		Based on 10 investigative samples, 1 duplicate, 1 trip blank, and 1 equipment blank per sampling event
Shipping	1	shipment	$70	$70		
Reporting	1	each	$11,000	$11,000		
					$14,100	
ANNUAL O&M COST SUBTOTAL FOR YEAR 8					$14,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEAR 8					$18,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$347,000	Assumes an interest factor of 7%

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

ENGINEER'S ESTIMATES						COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
SHALLOW GROUNDWATER SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-2						
Rotosonic Subcontractor	4	lump sum	$22,448	$89,792		Cost includes labor, mobilization, decon, well materials, and drilling. 10 locations were assumed to be investigated. Each boring is assumed completed to 45', with groundwater samples being collected from 35' to 45' and 40' to 45'.
Labor	320	hour	$80	$25,600		Based on 2 people for 4 days (10 hours per day) at 3 borings per day per sampling event.
Per Diem	32	man days	$85	$2,720		Based on 2 people for 4 days per sampling event.
Equipment	4	lump sum	$350	$1,400		Cost includes equipment rental and expendable supplies.
Rental Vehicle	16	day	$80	$1,280		
ANALYTICAL						
VOC Analysis (water)	104	sample	$90	$9,360		Based on 20 investigative samples, 2 trip blanks, 2 equipment blanks and 2 duplicate samples per sampling event.
Shipping	16	shipment	$70	$1,120		
Reporting	4	each	$11,000	$44,000		
					$175,300	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-2					$175,300	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-2					$219,000	
QUARTERLY MONITORING FOR YEARS 3-7						
Rotosonic Subcontractor	4	lump sum	$8,979	$35,917		Cost includes labor, mobilization, decon, well materials, and drilling. 4 (40%) locations were assumed to be investigated. Each boring is assumed completed to 45', with groundwater samples being collected from 35-40' and 40-45'.
Labor	96	hour	$80	$7,680		Based on 2 people for 1 day at 12 hours per day for each sampling event.
Per Diem	8	man days	$85	$680		Based on 2 people for 1 day per each sampling event.
Equipment	4	lump sum	$100	$400		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	4	day	$80	$320		
ANALYTICAL						
VOC Analysis (water)	44	sample	$90	$3,960		Assume 8 investigative samples, 1 trip blanks, 1 equipment blanks, and 1 duplicate sample per sampling event.
Shipping	4	shipment	$70	$280		
Reporting	4	each	$11,000	$44,000		
					$93,200	
ANNUAL O&M COST SUBTOTAL FOR YEARS 3-7					$93,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 3-7					$116,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$811,000	Assumes an interest factor of 7%

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
LONG-TERM AIR MONITORING PROGRAM						
QUARTERLY MONITORING FOR YEARS 1-2						
GEOPROBE SUBCONTRACTOR	4	lump sum	$12,646	$50,585		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 25 homes with 4 borings (or soil gas samples) at each home per sampling event.
OVERSIGHT OF WORK						
Labor	800	hour	$80	$64,000		Based on 2 people for 10 days (10 hours per day) per sampling event.
Per Diem	80	man days	$85	$6,800		Based on 2 people for 10 days per sampling event.
Equipment	4	lump sum	$350	$4,400		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	40	day	$80	$3,200		Based on 2 vehicles per sampling event for air sampling canisters.
ANALYTICAL						
VOC Analysis (air)	916	sample	$600	$549,600		Based on 175 investigative samples, 18 trip blanks, 18 equipment blanks, 18 duplicates
Shipping	228	shipment	$70	$15,960		Based on 4 sample containers per shipment
Reporting	4	each	$11,000	$44,000		
					$738,500	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-2					$738,500	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-2					$923,000	
QUARTERLY MONITORING FOR YEARS 3-7						
GEOPROBE SUBCONTRACTOR	4	lump sum	$7,377	$29,508		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 10 homes with 4 borings (or soil gas samples) at each home
OVERSIGHT OF WORK						
Labor	320	hour	$80	$25,600		Based on 2 people for 4 days (10 hours per day)
Per Diem	32	man days	$85	$2,720		Based on 2 people for 4 days.
Equipment	4	lump sum	$540	$5,160		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	16	day	$80	$1,280		
ANALYTICAL						
VOC Analysis (air)	376	sample	$600	$225,600		Based on 70 investigative samples, 4 trip blanks, 10 equipment blanks, 10 duplicates per sampling event.
Shipping	96	shipment	$70	$6,720		Based on 4 sample containers per shipment
Reporting	4	each	$11,000	$44,000		
					$340,600	
ANNUAL O&M COST SUBTOTAL FOR YEARS 3-7					$341,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 3-7					$426,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$3,194,000	Assumes an interest factor of 7%

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
SOIL SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-2						
Labor	800	hour	$80	$64,000		Based on 2 people for 10 days (10 hour day) at 10 locations per day.
Per Diem	80	man days	$85	$6,800		Based on 2 people for 10 days.
Equipment	4	lump sum	$1,000	$1,000		Cost includes rental of various equipment, as well as some purchase items
Rental Vehicle	40	day	$80	$3,200		
ANALYTICAL						
VOC Analysis (soil)	520	sample	$157	$81,640		Based on 100 investigative samples, 10 duplicates, 10 trip blanks, and 10 equipment blanks per sampling event.
Shipping	40	shipment	$70	$2,800		
Reporting	4	each	$11,000	$44,000		
					$203,400	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-2					$203,400	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-2					$254,000	
QUARTERLY MONITORING FOR YEARS 3-7						
Labor	320	hour	$80	$25,600		Based on 2 people for 4 days (10 hour day) at 10 locations per day.
Per Diem	32	man days	$85	$2,720		Based on 2 people for 4 days.
Equipment	4	lump sum	$400	$1,600		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	16	day	$80	$1,280		
ANALYTICAL						
VOC Analysis (soil)	208	sample	$157	$32,656		Based on 40 investigative samples, 4 duplicates, 4 trip blanks, and 4 equipment blanks per sampling event.
Shipping	16	shipment	$70	$1,120		
Reporting	4	each	$11,000	$44,000		
					$109,000	
ANNUAL O&M COST SUBTOTAL FOR YEARS 3-7					$109,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 3-7					$136,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$946,000	Assumes an interest factor of 7%

Alternative 2
Groundwater Pump-and-Treat System
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
ANNUAL SYSTEM OPERATION AND MAINTENANCE						
Annual Pump Maintenance	1	Event	$25,000	$25,000		
Annual Cleaning of Strippers	800	Hour	$80	$64,000		Assume 2 employees, 150 hours per month per employee, 12 months/yr
Annual Electricity Requirements	6,912,000	kW-hr	$0.1	$691,200		Assume 800 kw/hr for 23 blowers and 23 pumps.
					$780,200	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-8					$780,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-8					$975,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$5,822,000	Assumes an interest factor of 7%
ANNUAL EFFLUENT MONITORING						
Labor	288	HR	$80	$23,040		Assumes 1 Engineer@20 hours/month + 4 hours/month for travel
Per Diem	24	days	$85	$2,040		
Mob / Demob	15	HR	$80	$1,200		
Analytical						
Volatile Organic Compounds	40	Sample	$150	$6,000		2 effluent samples + blank per month. Includes shipping costs
Total Suspended Solids	12	Sample	$30	$360		Cost includes shipping. One sample per month.
Biochemical Oxygen Demand	12	Lump Sum	$100	$1,200		Cost includes shipping. One sample per month.
Reporting	4	Report	$6,000	$24,000		Quarterly report
H&S and Sampling Equipment	24	Days	$200	$4,800		1 day per month.
Rental Vehicle	24	Days	$60	$1,440		1 day per month.
					$64,080	
ANNUAL O&M COST SUBTOTAL FOR YEARS 8					$64,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 8					$80,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$478,000	Assumes an interest factor of 7%
SUB-TOTAL of DIRECT AND INDIRECT COSTS					$10,275,000	
SUB-TOTAL of DIRECT AND INDIRECT COSTS WITH 25% CONTINGENCY					$12,844,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$12,244,000	Assumes an interest factor of 7 %.
TOTAL COST (DIRECT COSTS + INDIRECT COSTS + PRESENT WORTH COSTS) WITH CONTINGENCY					$25,088,000	

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
DIRECT COSTS						
VERTICAL PROFILE SAMPLING						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$398,094	$398,094		Cost includes subcontractor labor, mobilization, decon, water sampling, boring abandonment, and drilling. Profiling will be done at 40 locations to a depth of 135 feet. Based on 10 samples per location.
OVERSIGHT OF WORK						
Labor	1280	hour	$80	$102,400		Based on 2 people for 64 days (10 hours per day)
Per Diem	128	man days	$85	$10,880		Based on 2 people for 64 days.
Equipment	1	lump sum	$8,500	$8,500		Cost includes rental of equipment and expendable supplies.
Rental Vehicle	64	day	$80	$5,120		
ANALYTICAL						
VOC Analysis (water)	530	sample	$90	$47,700		Based on 400 investigative samples, 40 duplicates, 40 equipment blank, and 50 trip blanks.
Shipping	50	shipment	$70	$3,500		
					$576,194	
PIEZOMETER INSTALLATION						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$40,471	$40,471		Cost includes subcontractor labor, mobilization, decon, well materials, and drilling. 10 piezometers will be installed to 50';1 piezometer will be installed to 100'
OVERSIGHT OF WORK						
Labor	80	hour	$80	$3,200		Based on 2 people for 4 days (10 hours per day).
Per Diem	8	man days	$85	$680		Based on 2 people for 4 days.
Equipment	1	lump sum	$1,500	$1,500		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	4	day	$80	$320		
					$46,171	
MONITOR WELL INSTALLATION						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$108,163	$108,163		Cost includes subcontractor labor, mobilization, decon, well materials, and drilling. Based on 10 wells to be installed to 50',10 wells to be installed to 100'
OVERSIGHT OF WORK						
Labor	360	hour	$80	$28,800		Based on 2 people for 18 days (10 hours per day).
Per Diem	36	man days	$85	$3,060		Based on 2 people for 18 days.
Equipment	1	lump sum	$500	$500		Cost includes equipment rental and expendable supplies.
Rental Vehicle	18	day	$80	$1,440		
					$141,963	

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
DEVELOPMENT OF NEWLY INSTALLED WELLS						
Labor	140	hour	$80	$11,200		Based on 3 wells per day (10 hours per day); total of 20 wells
Per Diem	14	man days	$85	$1,190		Based on 2 people for 7 days
Equipment	1	lump sum	$1,500	$1,500		Include equipment rental and expendable supplies
Rental Vehicle	7	day	$80	$560		
					$14,450	
BASELINE RESIDENTIAL WELL SAMPLING						
Pre-Sampling Labor	80	hour	$40	$3,200		Obtaining access agreements to sample at a residence, based on 10 access agreements signed per day (10 hours per day) for total of 73 wells (10 wells part of long term monitoring program)
Labor	140	hour	$80	$5,600		Based on 10 wells per day (10 hours per day) for 2 people (10 hours per day) for 7 days
Per Diem	14	man days	$85	$1,190		
Rental Vehicle	7	day	$80	$560		
Analytical						
VOC analysis (water)	84	sample	$90	$7,560		Based on 63 investigative samples, 7 duplicates, 7 trip blanks, and 7 equipment blanks
Shipping	7	shipment	$70	$490		
					$18,600	
SOIL VAPOR SAMPLING						
GEOPROBE SUBCONTRACTOR	1	lump sum	$21,077	$21,077		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 50 locations with 3 borings at each location (8', 20', and 30').
OVERSIGHT OF WORK						
Labor	300	hour	$80	$24,000		Based on 2 people for 15 days (10 hours per day)
Per Diem	30	man days	$85	$2,550		Based on 2 people for 15 days
Equipment	1	lump sum	$3,350	$3,350		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	15	day	$80	$1,200		
ANALYTICAL						
VOC Analysis (air)	195	sample	$600	$117,000		Based on 150 investigative samples, 15 trip blanks, 15 equipment blanks, 15 duplicate
Shipping	30	shipment	$70	$2,100		
					$171,277	

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
SHALLOW GROUNDWATER CHARACTERIZATION						
ROTOSONIC SUBCONTRACTOR	1	lump sum	$56,120	$56,120		Cost includes labor, mobilization, decon, well materials, and drilling. 50 locations will be investigated. Each boring will be completed to 45', with groundwater samples being collected from 35' to 40' and 40' to 45'.
OVERSIGHT OF WORK						
Labor	300	hour	$80	$12,000		Based on 2 people for 15 days (10 hours per day)
Per Diem	30	man days	$85	$2,550		Based on 2 people for 15 days.
Equipment	1	lump sum	$350	$350		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	15	day	$80	$1,200		
ANALYTICAL						
VOC analysis (water)	130	sample	$90	$11,700		Based on 100 investigative samples, 10 trip blanks, 10 equipment blanks, 10 duplicate
Shipping	15	shipment	$70	$1,050		
					$84,970	
ADDITIONAL SOIL SAMPLING						
GEOPROBE SUBCONTRACTOR	1	lump sum	$1,878	$1,878		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 10 borings to be drilled to 10ft
OVERSIGHT OF WORK						
Labor	24	hour	$80	$1,920		Based on 2 people for 1 day (12 hour per day).
Per Diem	2	man days	$85	$170		Based on 2 people for 1 day
Equipment	1	lump sum	$200	$200		Cost includes rental of various equipment, as well as some purchase items
Rental Vehicle	1	day	$80	$80		
ANALYTICAL						
VOC Analysis (soil)	65	sample	$157	$10,205		Based on 5 soil samples per boring, 5 trip blanks, 5 equipment blanks, 5 duplicates
Shipping	1	shipment	$70	$70		
					$14,523	
SEPTIC SYSTEM CHARACTERIZATION						
SUBCONTRACTOR WORK						
Geoprobe Subcontractor	1	lump sum	$7,960	$7,960		Cost includes subcontractor labor, mobilization, decon, and materials. For soil gas, 10 homes are assumed to be investigated with 3 samples per home to the depth of 15 feet. For soil sampling, 10 homes were assumed to be investigated with 3 samples per home to the depth of 10 feet.
Rotosonic Subcontractor	1	lump sum	$11,224	$11,224		Cost includes labor, mobilization, decon, well materials, and drilling. 10 homes were assumed to be investigated. It was assumed that one boring will be completed at each home to the depth of 45 feet. Groundwater samples to be collected from 35-40 and 40-45 feet bgs.
OVERSIGHT OF WORK						
Labor	100	hour	$80	$8,000		Based on 2 people for 5 days (10 hours per day).
Per Diem	10	man days	$85	$850		Based on 2 people for 5 days.
Equipment	1	lump sum	$1,250	$1,250		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	5	day	$80	$400		
ANALYTICAL						
VOC analysis (soil)	39	sample	$157	$6,123		Based on 30 investigative samples, 3 equipment blank, 3 trip blank, 3 duplicate samples
VOC analysis (water)	27	sample	$90	$2,430		Based on 20 investigative samples, 2 equipment blank, 3 trip blank, 2 duplicate samples
VOC analysis (air)	36	sample	$600	$21,600		Based on 30 investigative samples, 3 equipment blank, 3 trip blank
Shipping	14	shipment	$70	$980		Based on 14 packages
					$60,817	
DIRECT COST SUBTOTAL					$1,129,000	

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	*Unit*	*Unit Price*	*Cost*	*Subtotal*	
INDIRECT COSTS						
ENGINEERING/DESIGN/INVESTIGATION						
Engineering and Design	1	-	$112,900	$112,900		10% capital costs
					$112,900	
CONTRACTOR PROCUREMENTS	1	Lump Sum	$25,000	$25,000		
					$25,000	
BONDS AND INSURANCE	1	Lump Sum	$90,320	$90,320		8% capital costs
					$90,300	
REPORT WRITING	1	Lump Sum	$66,000	$66,000		
					$66,000	
ADDITIONAL CHARACTERIZATION						
HOME OFFICE LABOR						
Project Planning	1	Lump Sum		$22,000		
					$22,000	
INDIRECT COST SUBTOTAL					$316,000	

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
ANNUAL OPERATIONS AND MAINTENANCE (O&M) COSTS						
MONITORING WELL SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-5						
Labor	800	hour	$80	$64,000		Based on 3 wells per day (10 hours per day) per sampling event. 30 wells are assumed to be sampled.
Per Diem	80	man days	$85	$6,800		
Equipment	4	lump sum	$2,500	$10,000		Includes equipment rental and expendable supplies.
Rental Vehicle	40	day	$80	$3,200		
ANALYTICAL						
VOC Analysis (water)	184	sample	$90	$16,560		Based on 30 investigative samples, 3 duplicate, 10 trip blanks, and 3 equipment blanks per sampling event.
Water Quality Parameters	33	sample	$500	$16,500		Based on 30 investigative samples and 3 duplicate samples. Only one sampling event is assumed.
Shipping	40	shipment	$70	$2,800		
Reporting	4	each	$11,000	$44,000		
					$163,900	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-5					$163,900	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-5					$205,000	
SEMIANNUAL MONITORING FOR YEARS 6-10						
Labor	400	hour	$80	$32,000		Based on 3 wells per day (10 hours per day) per sampling event.
Per Diem	40	man days	$85	$3,400		
Equipment	2	lump sum	$2,500	$5,000		Includes equipment rental and expendable supplies.
Rental Vehicle	20	day	$80	$1,600		
ANALYTICAL						
VOC Analysis (water)	92	sample	$90	$8,280		Based on 30 investigative samples, 3 duplicate, 10 trip blanks, and 3 equipment blanks per sampling event.
Shipping	20	shipment	$70	$1,400		
Reporting	2	each	$11,000	$22,000		
					$73,700	
ANNUAL O&M COST SUBTOTAL FOR YEARS 6-10					$73,700	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEAR 6-10					$92,000	
ANNUAL MONITORING FOR YEARS 11-15						
Labor	200	hour	$80	$16,000		Based on 3 wells per day (10 hours per day) per sampling event.
Per Diem	20	man days	$85	$1,700		
Equipment	1	lump sum	$2,500	$2,500		Includes equipment rental and expendable supplies.
Rental Vehicle	10	day	$80	$800		
ANALYTICAL						
VOC Analysis (water)	46	sample	$90	$4,140		Based on 30 investigative samples, 3 duplicate, 10 trip blanks, and 3 equipment blanks per sampling event.
Shipping	10	shipment	$70	$700		
Reporting	1	each	$11,000	$11,000		
					$36,800	
ANNUAL O&M COST SUBTOTAL FOR YEARS 11-15					$37,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 11-15					$46,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$1,205,000	Assumes an interest factor of 7%

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

ENGINEER'S ESTIMATES	Quantity	Unit	Unit Price	Cost	Subtotal	COMMENTS
RESIDENTIAL WELL SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-5						
Labor	80	hour	$80	$6,400		Based on 10 wells per day (10 hours per day), based on 2 people sampling team per sampling event
Per Diem	8	man days	$85	$680		Based on 2 people for one day per sampling event
Rental Vehicle	4	day	$80	$320		
ANALYTICAL						
VOC Analysis (water)	52	sample	$90	$4,680		Based on 10 investigative samples, 1 duplicate, 1 trip blank, and 1 equipment blank per sampling event
Shipping	4	shipment	$70	$280		
Reporting	4	each	$11,000	$44,000		
					$56,400	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-5					$56,400	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-5					$71,000	
SEMIANNUAL MONITORING FOR YEARS 6-10						
Labor	40	hour	$80	$3,200		Based on 10 wells per day (10 hours per day), based on 2 people sampling team per sampling event
Per Diem	4	man days	$85	$340		Based on 2 people for one day per sampling event
Rental Vehicle	2	day	$80	$160		
ANALYTICAL						
VOC Analysis (water)	26	sample	$90	$2,340		Based on 10 investigative samples, 1 duplicate, 1 trip blank, and 1 equipment blank per sampling event
Shipping	2	shipment	$70	$140		
Reporting	2	each	$11,000	$22,000		
					$28,200	
ANNUAL O&M COST SUBTOTAL FOR YEARS 6-10					$28,200	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEAR 6-10					$35,000	
ANNUAL MONITORING FOR YEARS 11-15						
Labor	20	hour	$80	$1,600		Based on 10 wells per day (10 hours per day), based on 2 people sampling team per sampling event
Per Diem	2	man days	$85	$170		Based on 2 people for one day per sampling event
Rental Vehicle	1	day	$80	$80		
ANALYTICAL						
VOC Analysis (water)	13	sample	$90	$1,170		Based on 10 investigative samples, 1 duplicate, 1 trip blank, and 1 equipment blank per sampling event
Shipping	1	shipment	$70	$70		
Reporting	1	each	$11,000	$11,000		
					$14,100	
ANNUAL O&M COST SUBTOTAL FOR YEARS 11-15					$14,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 11-15					$18,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$431,000	Assumes an interest factor of 7%

Al[illegible]ative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
SHALLOW GROUNDWATER SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-2						
Rotosonic Subcontractor	4	lump sum	$22,448	$89,792		Cost includes labor, mobilization, decon, well materials, and drilling. 10 locations were assumed to be investigated. Each boring is assumed completed to 45', with groundwater samples being collected from 35' to 40' and 40' to 45'.
Labor	320	hour	$80	$25,600		Based on 2 people for 4 days (10 hours per day) at 3 borings per day per sampling event.
Per Diem	32	man days	$85	$2,720		Based on 2 people for 4 days per sampling event.
Equipment	4	lump sum	$350	$1,400		Cost includes equipment rental and expendable supplies.
Rental Vehicle	16	day	$80	$1,280		
ANALYTICAL						
VOC Analysis (water)	104	sample	$90	$9,360		Based on 20 investigative samples, 2 trip blanks, 2 equipment blanks and 2 duplicate samples per sampling event.
Shipping	16	shipment	$70	$1,120		
Reporting	4	each	$11,000	$44,000		
					$175,300	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-2					$175,300	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-2					$219,000	
QUARTERLY MONITORING FOR YEARS 3-7						
Rotosonic Subcontractor	4	lump sum	$8,979	$35,917		Cost includes labor, mobilization, decon, well materials, and drilling. 4 (40%) locations were assumed to be investigated. Each boring is assumed completed to 45', with groundwater samples being collected from 35-40' and 40-45'.
Labor	96	hour	$80	$7,680		Based on 2 people for 1 day at 12 hours per day for each sampling event.
Per Diem	8	day	$85	$680		Based on 2 people for 1 day per each sampling event.
Equipment	4	lump sum	$100	$400		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	4	day	$80	$320		
ANALYTICAL						
VOC Analysis (water)	44	sample	$90	$3,960		Assume 8 investigative samples, 1 trip blanks, 1 equipment blanks, and 1 duplicate sample per sampling event.
Shipping	4	shipment	$70	$280		
Reporting	4	each	$11,000	$44,000		
					$93,200	
ANNUAL O&M COST SUBTOTAL FOR YEARS 3-7					$93,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 3-7					$116,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$811,000	Assumes an interest factor of 7%

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

ENGINEER'S ESTIMATES	Quantity	Unit	Unit Price	Cost	Subtotal	COMMENTS
LONG-TERM AIR MONITORING PROGRAM						
QUARTERLY MONITORING FOR YEARS 1-2						
GEOPROBE SUBCONTRACTOR	4	lump sum	$12,646	$50,585		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 25 homes with 4 borings (or soil gas samples) at each home per sampling event.
OVERSIGHT OF WORK						
Labor	800	hour	$80	$64,000		Based on 2 people for 10 days (10 hours per day) per sampling event
Per Diem	80	man days	$85	$6,800		Based on 2 people for 10 days per sampling event
Equipment	4	lump sum	$350	$4,400		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	40	day	$80	$3,200		2 vehicles per sampling event for air sampling canisters
ANALYTICAL						
VOC Analysis (air)	916	sample	$600	$549,600		Based on 175 investigative samples, 18 trip blanks, 18 equipment blanks, 18 duplicates
Shipping	228	shipment	$70	$15,960		Based on 4 sample containers per shipment
Reporting	4	each	$11,000	$44,000		
					$738,500	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-2					$738,500	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-2					$923,000	
QUARTERLY MONITORING FOR YEARS 3-7						
GEOPROBE SUBCONTRACTOR	4	lump sum	$7,377	$29,508		Cost includes subcontractor labor, mobilization, decon, and materials. Based on 10 homes with 4 borings (or soil gas samples) at each home
OVERSIGHT OF WORK						
Labor	320	hour	$80	$25,600		Based on 2 people for 4 days (10 hours per day)
Per Diem	32	man days	$85	$2,720		Based on 2 people for 4 days.
Equipment	4	lump sum	$540	$5,160		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	16	day	$80	$1,280		
ANALYTICAL						
VOC Analysis (air)	376	sample	$600	$225,600		Based on 70 investigative samples, 4 trip blanks, 10 equipment blanks, 10 duplicates per sampling event.
Shipping	96	shipment	$70	$6,720		Based on 4 sample containers per shipment
Reporting	4	each	$11,000	$44,000		
					$340,600	
ANNUAL O&M COST SUBTOTAL FOR YEARS 3-7					$341,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 3-7					$426,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$3,194,000	Assumes an interest factor of 7%

Alternative 3
Natural Attenuation
Evergreen Manor Site
Roscoe, Illinois

	ENGINEER'S ESTIMATES					COMMENTS
	Quantity	Unit	Unit Price	Cost	Subtotal	
SOIL SAMPLING						
QUARTERLY MONITORING FOR YEARS 1-2						
Labor	800	hour	$80	$64,000		Based on 2 people for 10 days (10 hour day) at 10 locations per day.
Per Diem	80	man days	$85	$6,800		Based on 2 people for 10 days.
Equipment	4	lump sum	$1,000	$1,000		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	40	day	$80	$3,200		
ANALYTICAL						
VOC Analysis (soil)	520	sample	$157	$81,640		Based on 100 investigative samples, 10 duplicates, 10 trip blanks, and 10 equipment blanks per sampling event.
Shipping	40	shipment	$70	$2,800		
Reporting	4	each	$11,000	$44,000		
					$203,400	
ANNUAL O&M COST SUBTOTAL FOR YEARS 1-2					$203,400	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 1-2					$254,000	
QUARTERLY MONITORING FOR YEARS 3-7						
Labor	800	hour	$80	$64,000		Based on 2 people for 4 days (10 hour day) at 10 locations per day.
Per Diem	32	man days	$85	$2,720		Based on 2 people for 4 days.
Equipment	4	lump sum	$400	$1,600		Cost includes rental of various equipment, as well as some purchase items.
Rental Vehicle	16	day	$80	$1,280		
ANALYTICAL						
VOC Analysis (soil)	208	sample	$157	$32,656		Based on 40 investigative samples, 4 duplicates, 4 trip blanks, and 4 equipment blanks per sampling event.
Shipping	16	shipment	$70	$1,120		
Reporting	4	each	$11,000	$44,000		
					$147,400	
ANNUAL O&M COST SUBTOTAL FOR YEARS 3-7					$147,000	
SUB-TOTAL of ANNUAL O&M COSTS WITH 25% CONTINGENCY FOR YEARS 3-7					$184,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$1,118,000	Assumes an interest factor of 7%
SUB-TOTAL of DIRECT AND INDIRECT COSTS					$1,445,000	
SUB-TOTAL of DIRECT AND INDIRECT COSTS WITH 25% CONTINGENCY					$1,806,000	
PRESENT WORTH of O&M COSTS WITH CONTINGENCY					$6,759,000	
TOTAL COST (DIRECT COSTS + INDIRECT COSTS + PRESENT WORTH COSTS) WITH CONTINGENCY					$8,565,000	